Webster Lake
Aquatic Vegetation Management Plan

February 2, 2005

Prepared for:
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Executive Summary

Aquatic Control was contracted by the Webster Lake Conservation Association to complete aquatic vegetation sampling in order to update their lakewide, long-term integrated aquatic vegetation management plan. Funding for development of this plan was obtained from the Webster Lake Conservation Association and the Indiana Department of Natural Resources-Division of Soil Conservation as part of the Lake and River Enhancement fund (LARE). This plan was updated as a prerequisite to eligibility for LARE program funding to control exotic or nuisance species. The original aquatic vegetation management plan was created after a recommendation from the 2000 diagnostic study for Webster and Backwater Lakes.

Aquatic vegetation is an important component of lakes in Indiana; however, as a result of many factors this vegetation can develop to a nuisance level. Nuisance aquatic vegetation, as used in this paper, describes plant growth that negatively impacts the present uses of the lake including fishing, boating, swimming, aesthetic and lakefront property values. The primary nuisance species within Webster and Backwater Lakes are the exotic plants Eurasian watermilfoil (*Myriophylum spicatum)* and curlyleaf pondweed (*Potamogetan crispus)*. The negative impact of these species on native aquatic vegetation, fish populations, water quality, and other factors is well documented. Other nuisance vegetation, which has historically shown negative impacts on Webster Lake, include the native species coontail (*Ceratophyllum demersum)* and duckweed (*Lemna sp*.). Due to the morphology of the lakes and extensive shallow areas, a large percentage of the lakes can become infested with heavy growths of these nuisance species. These plants inhibit the recreational uses of the lakes, including: boating, swimming, water skiing, fishing, and may degrade the fish habitat when maximum growth is allowed to occur. The primary recommendation for plant control within Webster Lake is the selective control of Eurasian watermilfoil with triclopyr herbicide. Triclopyr is a relatively new active ingredient in the aquatics market and shows a great deal of promise for selectively controlling Eurasian watermilfoil. Eurasian watermilfoil should be treated anywhere it occurs in the Webster Chain. A whole lake fluridone treatment should only be initiated if the spread of this species cannot be controlled with triclopyr herbicide. A whole lake fluridone treatment should be initiated if it becomes necessary to treat more than 100 acres of Eurasian watermilfoil (this number was selected based on cost of treating with triclopyr versus fluridone). Whole-lake fluridone treatments have been proven through numerous field studies throughout the United States to provide the most cost effective and selective control for Eurasian watermilfoil and other exotic, invasive aquatic macrophytes, when they attain large-scale infestations. In 2005, a trial treatment of the exotic species curlyleaf pondweed should be initiated. A maximum of 20 acres of the most dense curlyleaf pondweed areas should be treated in April with Aquathol K herbicide. Research has shown that repeated early season curlyleaf pondweed treatments can reduce turion production over time. These areas should be monitored in future plant surveys to assess the effectiveness of this treatment strategy. Submersed vegetation should also be treated in high-use residential areas in order to reduce nuisance conditions. Contact herbicides should be used for this treatment. The contact treatment should not exceed 100 feet perpindicular distance from the shoreline and should not exceed 65 acres.

The demands upon the lake for recreation, aesthetics and fishing along with the historically documented aquatic plant problems within the lake make a periodic large scale fluridone application for the systemic control of exotic species the most effective plant control method available at this time. However, in order to prolong the effects of the fluridone treatment, triclopyr herbicide should be the primary tool for controlling Eurasian watermilfoil and Aquathol K should be used for control of curlyleaf pondweed. If Eurasian watermilfoil and curlyleaf pondweed continue to spread following these treatments, a whole lake fluridone treatment should be initiated. Based on cost per acre of treatment, a fluridone treatment should be initiated if over 100 acres of Eurasian watermilfoil require treatment. An increase in vegetation monitoring will be necessary to assess the effectiveness of the proposed treatments. In addition, annually selected small area treatments with contact herbicides, educational efforts, and plantings of beneficial species should be integrated into the long-range aquatic vegetation management plan for Webster Lake.

Acknowledgements

Funding for the vegetation sampling and preparation of an aquatic vegetation management plan was provided by the Indiana Department of Natural Resources – Division of Soil Conservation and the Webster Lake Conservation Association. Aquatic Control Inc completed the 2004 fieldwork, data processing, and map generation. Remetrix, LLC and Aquatic Control Inc. completed 2001 field work, data processing, and map generation. Identification and verification of some plant specimens was provided by Dr. Robin Scribailo of Purdue University North Central. Special thanks are given to Mr. Tom Plew of the Webster Lake Conservation Association for their help in initiating and completing this project. Special thanks are given to Jed Pearson, District Fisheries Biologist for the Indiana Department of Natural Resources-Division of Fish And Wildlife, for his assistance with the plant sampling database and review of this report. Special thanks are given to Cecil Rich, Biologist for the Indiana Department of Natural Resources-Division of Soil Conservation for his review and editing of this report. Author of this report is Nathan Long of Aquatic Control. The author would like to acknowledge the valuable input from David Isaacs, Brian Isaacs, Joey Leach, Brendan Hastie, and Barbie Huber of Aquatic Control for their field assistance, map generation, review, and editing of this report.

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Introduction

Aquatic Control was contracted by the Webster Lake Conservation Association to complete aquatic vegetation sampling in order to update a lakewide, long-term integrated aquatic vegetation management plan. Funding for the update of this plan was obtained from the Indiana Department of Natural Resources-Division of Soil Conservation as part of the Lake and River Enhancement fund (LARE). This plan was also updated as a prerequisite to eligibility for LARE program funding to control exotic or nuisance species.

The original vegetation management plan was developed following a recommendation from the 2000 diagnostic study. "Such a plan should target nuisance populations such as Eurasian watermilfoil, curlyleaf pondweed, and duckweed, while protecting native pondweeds. The plan should set reasonable reduction goals, acknowledging the basin morphology of the lakes predisposes them to nuisance aquatic plant growth. The plan should recognize vital roles performed by aquatic plants in a healthy lake ecosystem. In other words, complete eradication of aquatic plants is neither desired nor feasible (J.F. New & Associates, Inc., 2000)".

The following summary is given for the survey conducted by J.F. New & Associates in May of 1999. Curlyleaf pondweed and Eurasian watermilfoil dominated the lake macrophyte community, but they have not completely eliminated native plants. Spatterdock (*Nuphar advena*), pickerel weed (*Pantederia cordata*), coontail, and pondweeds are typical natives in the Northern Lakes Natural Region (Homoya et al., 1985). Healthy individuals of these species were noted in Webster Lake. In addition, patches of large-leaf pondweed, which provides excellent fish habitat (Curtis, 1998), exist in certain sections of the lake. Lastly, whorled milfoil (*Myriophyllum verticillatum)* which is state threatened species was observed in Webster Lake (J.F. New & Associates, Inc., 2000). It is important to note the presence of curlyleaf pondweed and Eurasian watermilfoil is typical for northern Indiana Lakes. These species were observed in every lake in Kosciusko County in 1997 (White, 1998a). Moreover, their absence was only documented in seven lakes in 15 of the northern counties in Indiana. These 15 counties include all of the counties in northeastern Indiana where most of Indiana's natural lakes are located. Of the northern lakes receiving permits to treat aquatic plants in 1998, Eurasian watermilfoil was listed as the primary target in those permits (White, 1998b; J.F. New & Associates, Inc., 2000).

Webster and Backwater Lakes are conducive to nuisance aquatic plant growth based upon their morphology, the species present and available nutrients. Eurasian watermilfoil has covered in excess of half the lake's surface area, thereby impeding recreational uses, aesthetics, and potentially having negative impacts to the fishery and surrounding property values. Annual treatments have been completed to control nuisance aquatic vegetation since at least 1982 (Shuler et. al., 2004).

Watershed and Water Body Characteristics

Webster Lake, Backwater Lake, Kiser Lake, Goldeneye Pond, Ruddy Pond, Grindle Lake North, and Grindle Lake South are seven of several lakes located along the Tippecanoe River east of North Webster, Indiana (Kiser Lake, Goldeneye Pond, Ruddy Pond, Grindle Lake North and Grindle Lake South were not included in the 2004 sampling due to time limitations, difficult access, and lack of permanent residences; however they should be visually surveyed for the presence of Eurasian watermilfoil in the spring of 2005). The Tippecanoe River originates at Crooked Lake in Whitley County and flows northwest through Whitley and Noble Counties. Five lakes are located upstream of Backwater Lake on the Tippecanoe River: Crooked Lake, Big Lake, Smalley Lake, Baugher Lake, and Wilmot Pond. Upstream of the Backwaters, the Tippecanoe River has several tributaries, many with additional lakes located along their reaches as well. Other smaller drainages, including Gaff Ditch, flow directly to Webster Lake and Backwater Lake (J.F. New & Associates, Inc., 2000).

Figure 1. Lakes in the immediate Webster Lake watershed.

Webster Lake and the Backwaters watershed encompass approximately 31,275 acres (12,662ha) or 49 square miles (127 km^2). This results in a watershed area to lake area ratio of approximately 40:1. Watershed size can affect the chemical and biological characteristics of a lake. For example, lakes with large watersheds such as Webster Lake, have the potential to receive more pollutants (sediments, nutrients, pesticides, etc.) from runoff than lakes with smaller watersheds (J.F. New & Associates, Inc., 2000).

The land use associated with a watershed can have significant effects on the overall health of the bodies of water located within the watershed. Nearly 70% of the land in the Webster Lake watershed is used for agricultural purposes, including cropland, pasture, and agricultural woodlots. Land use in the Webster Lake watershed is typical of the counties in which it lies. Forested land and wetlands account for much of the remaining land in the Webster watershed (17.8% and 6.8% respectively). Less than one percent of the land in the watershed is utilized for residential or commercial purposes (J.F. New & Associates, Inc., 2000).

The area that is being considered in the vegetation management plan consists of seven interconnected bodies of water. The area includes, Webster Lake, Backwater Lake, Kiser Lake, Goldeneye Pond, Ruddy Pond, Grindle Lake North, and Grindle Lake South. Ruddy Pond is the smallest water body that was surveyed measuring 5.01 surface acres (2.03 ha) and is the only water body not connected to Webster Lake. Grindle Lake North is also located through the channel in the northeast corner of Webster Lake. It measures 11.32 surface acres (4.58 ha) and has a mean depth of 4.10 feet (1.25 m). Grindle Lake South measures 16.17 surface acres (6.54 ha) and has a mean depth of 4.35 feet (1.33 m). Goldeneye Pond is also in the Northeast corner of Webster Lake. It measures 26.46 surface acres (10.71 ha) and has a mean depth of 6.33 feet (1.99 m).

Southeast of Webster Lake is Backwater Lake and Kiser Lake. Kiser Lake can be accessed through a small channel in the southeast corner of Backwater Lake. It measures 18.04 surface acres (7.30 ha) and has a mean depth of 5.48 feet (1.67 m). Backwater Lake feeds into Webster Lake in the southeast corner (Figure 2). It is a very shallow lake, which measures 203.26 acres (82.26 ha) and has a mean depth of 2.89 feet (0.88 m).

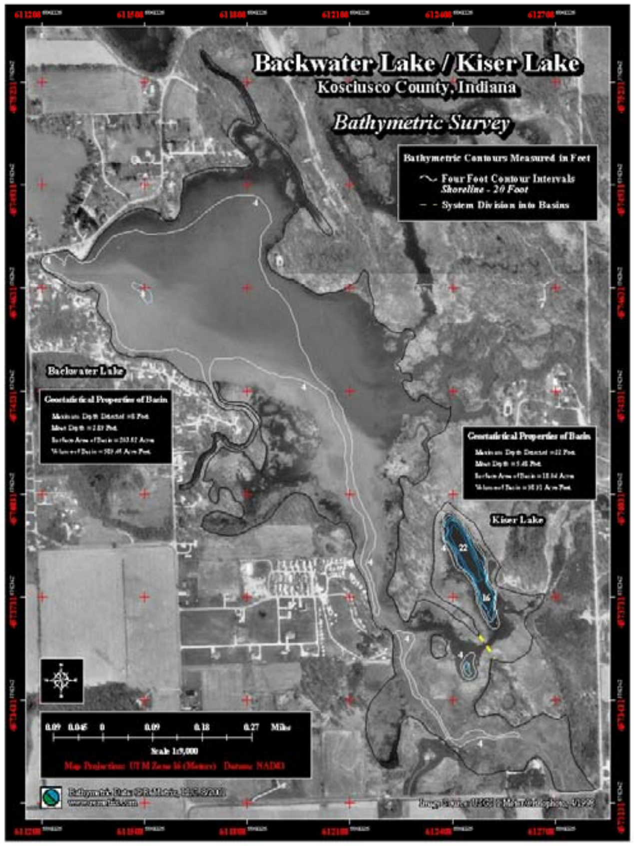

Figure 2. Bathymetric Map of Backwater Lake (Remetrix, 2001)

Webster Lake is the largest of the lakes surveyed. It measures 653.18 surface acres (264.34 ha) and has a mean depth of 11.97 feet (3.65 m). The majority of the shoreline is residentially developed. Currently, seawalls line approximately 95% of the developed shoreline. The water from Webster Lake flows through a spill way and forms the Tippecanoe River. Several authors (Blatchley, 1900; Shipman 1977; Pearson, 1985, 1989, 1995, and 1999) suggest that damming of the Tippecanoe River in the 1800's raised the water level enough to flood five small lakes, forming one large lake, Webster Lake. This can be seen by looking at a bathymetric map (Figure 3). There are five distinct basins scattered throughout what is now Webster Lake (J.F. New & Associates, Inc., 2000).

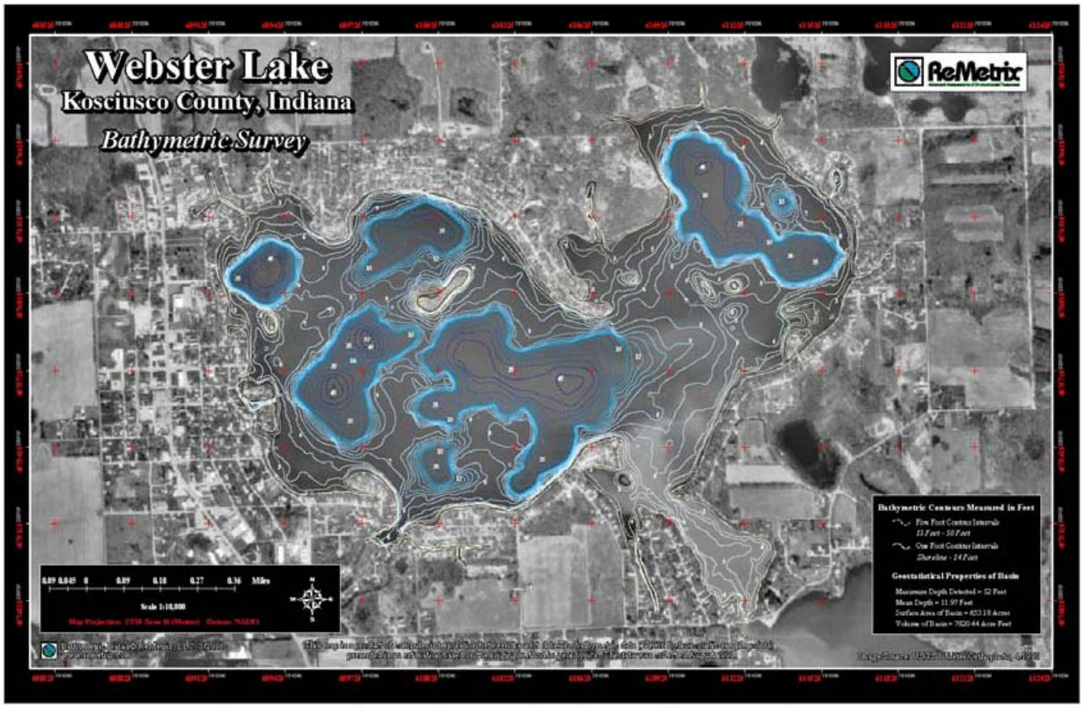

Figure 3. Bathymetric Map of Webster Lake (Remetrix, 2001)

Webster Lake has a watershed that is conducive to siltation and phosphorus loading. This can lead to nuisance algae blooms, increased shallow areas, and an overall degradation of water quality. However, improvement of the watershed and reduction in phosphorus loading will not control nuisance macrophytes. Typically, as watersheds are improved, water clarity will increase. This in turn will increase light penetration and allow for vegetation to grow in deeper water. Submersed vegetation obtains the majority of necessary nutrients from the sediment and most Indiana sediments contain sufficient nutrients for plant growth. Based upon Aquatic Control's observations over the last thirty-nine years, we believe aquatic plants are not significantly limited by available phosphorus present in the water column. Biologists from the Department of Fisheries and Aquatic Sciences at the University of Florida recently conducted a study comparing the amount of available nutrients to plant growth. They sampled aquatic plants in 319 lakes between 1983 and 1999 and found no significant correlation between nutrients in lake water and the abundance of rooted aquatic plants (Bachmann et. al.).

Fisheries (summarized from J.F. New & Associates, Inc., 2000)

Prior to 1976, very few fish surveys were conducted on Webster Lake and the Backwater areas. However, in 1976, the IDNR began conducting systematic fisheries surveys on the lakes. These are in addition to the muskellunge (*Esox masquinongy)* sampling and creel surveys conducted in the 1980's and 1990's. In general, the fish community in Webster Lake has remained reasonably stable in the past two and a half decades. Bluegill (*Lepomis macrochirus)* continue to dominate the fishery accounting for 40.7% to 67.2% of the number of individuals collected each survey year. The population appears to be stunted with an over-abundance of small slow growing individuals. The largemouth bass (*Micropterus salmoides)* population has fluctuated with inconsistent reproductive success, which is common in most northeastern Indiana bass populations. The dominance of small slow growing bluegill is likely to continue in Webster Lake, due to the physical characteristics of the lake. Thick stands of aquatic macrophytes dominate Webster Lake's abundant nutrient rich shallow water. As long as these conditions exist the bluegill population will remain over-abundant. The results of the most recent survey are summarized in Table 1.

Table 1. Relative abundance and size of fish collected from Webster Lake (Pearson, 1999).

Common Name	Number	Percent	Length range (in)	Weight (lb)	Percent
Bluegill	1148	64.4	1.1 - 9.6	116.70	31.5
Gizzard shad	174	9.8	3.0 - 15.1	60.89	16.4
Yellow perch	108	6.1	1.7 - 9.6	16.84	4.5
Black crappie	101	5.7	3.8 - 14.1	29.31	7.9
Largemouth bass	86	4.8	2.2 - 21.1	63.96	17.3
Redear	54	3.0	2.6 - 8.0	8.91	2.4
Yellow bullhead	43	2.4	8.0 - 13.5	24.68	6.7
Warmouth	24	1.3	2.3 - 6.7	2.57	0.7
Pumpkinseed	9	0.5	5.0 - 6.2	1.35	0.4
Brown bullhead	9	0.5	6.8 - 12.9	7.19	1.9
Spotted gar	6	0.3	19.1 - 32.4	16.92	4.6
Bluntnose minnow	5	0.3	1.3 - 3.2	0.05	0.0
Hybrid sunfish	4	0.2	5.6 - 7.1	0.76	0.2
Golden shiner	3	0.2	2.0 - 7.7	0.37	0.1
Longear	2	0.1	4.6 - 5.0	0.18	0.0
Brook silverside	2	0.1	1.8 - 3.0	0.01	0.0
Logperch	2	0.1	3.7 - 4.3	0.05	0.0
Carp	2	0.1	23.7 - 29.0	18.50	5.0
Bowfin	1	0.1	16.5	1.49	0.4
TOTAL	1783			370.73	

Webster Lake is known as the premier muskie lake in the state of Indiana. This is due to an intense stocking effort conducted by the Department of Natural Resources since 1978. Based on 1998 mark-recapture sampling, Webster Lake contained an estimated 1,181 adult muskie (>30-in). Nearly 23% of anglers fishing Webster Lake pursued this species. As many as 89% of muskie anglers rated fishing as 'good'. The stocking program had no adverse effects on the native fish community and it was recommended that the DNR continue with the muskie stocking program (Pearson, 1999).

Dense bed of submersed vegetation can have negative impacts on fish populations, especially largemouth bass and bluegill populations. Dr. Mike Maceina of Auburn University found that dense stands of Eurasian watermilfoil on Lake Guntersville proved to be detrimental to bass recruitment due to the survival of too many small bass. This led to below normal growth rates for largemouth bass and lower survival to age 1. Maceina found higher age 1 bass density in areas that contained no plants verses dense Eurasian watermilfoil stands (Maceina, 2001). It is well known by fisheries biologists that overabundant dense plant cover gives bluegill an increased ability to avoid predation and increases the survival of small young fish, which can lead to stunted growth. The Michigan Department of Natural Resources recently evaluated the effects of whole lake fluridone treatments on sport fish populations in nine different Michigan lakes for six years. They found modest statistically meaningful responses in most fish populations following treatment. From a fisheries perspective, all lake responses except one were improvements because all treatment lakes except one had a history of small-size, slow-growing, over-abundant bluegills (Schneider, 2000).

Present Water Body Uses

In the summer months Webster Lake is a very popular boating, swimming, and water skiing destination. A public beach is located on the western side of Webster Lake. There are also several private beaches and marinas on the lake (Figure 4). Pleasure boating and water skiing is aided by expansive areas of open water. The majority of the open water is deep enough on Webster Lake to accommodate most pleasure boats. In the past, dense beds of Eurasian watermilfoil have interfered with this activity during the summer months. According to Jed Pearson, the Eurasian watermilfoil was inhibiting all boating activities in 1998 (The Mail-Journal August 25, 1999). Many residents complained about having to stop and clean the milfoil out of their propellers prior to the 1999 Sonar treatment (The Mail-Journal August 25, 1999).

Figure 4. Webster Lake Usage Map (not to scale see appendix)

Approximately 832 homes line the shore and channels of Webster Lake while approximately 75 homes exist along the Backwaters shoreline. Of the 832 homes on Webster Lake, 285 are permanent residences, while 547 are used on a seasonal and weekend basis (J.F. New & Associates, Inc., 2000). The majority of the residents have docks and/or swimming areas in front of their residences. During the summer months, many of the residents enjoy fishing and swimming near their homes.

Webster Lake is also the destination of many largemouth bass and muskie fishermen. Several bass and muskie tournaments are staged from the public access site located in Backwater Lake (Figure 5). Webster Lake is known as one of the premier muskie lakes in the Midwest.

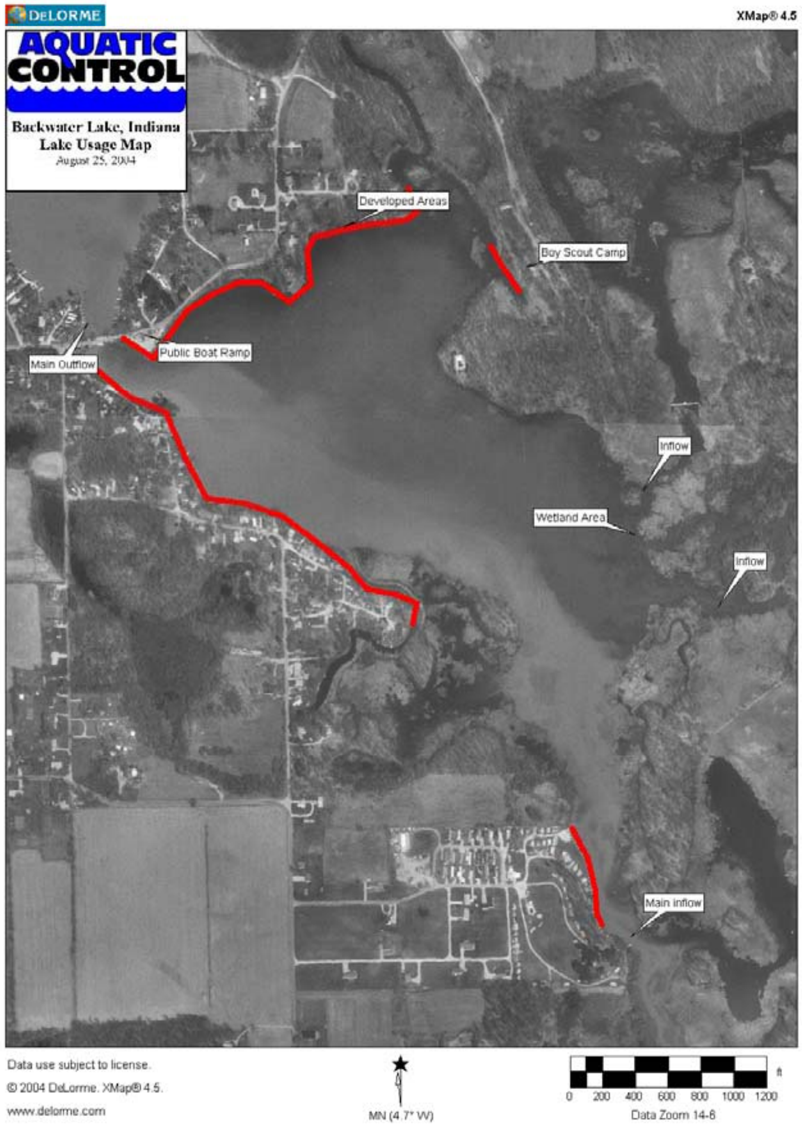

Figure 5. Backwater Lake Usage Map (not to scale see appendix)

Aquatic Plant Community

Sampling of Webster Lake's aquatic vegetation has been completed on several occasions with a variety of different sampling techniques (Appendix A). Remetrix LLC and Aquatic Control completed some of the most detailed vegetation sampling in 2001 prior to development of the original Webster Lake Aquatic Vegetation Management Plan. This sampling took place one year before a whole lake fluridone treatment. In 2001, a new and innovative technique using advanced hydroacoustic equipment to record vegetation density and prepare an updated bathymetric map was used on Webster Lake. Funding for point and hydroacousic plant sampling was provided by the LARE program.

The 2001 hydroacoustic plant sampling detected plant coverage within Webster Lake (Figure 6). Approximately 80% of the 16,230 sample points utilized by the computer interpolation detected some vegetative cover. In other words, 80% of the lake's surface area contained some vegetation with only 133 acres (53.8 ha) of the lake without plants. The mean cover for the lake was 60%. This statistic accounts for the amount of coverage at each sample point (i.e. a sample point may have only had a 10% or 40% coverage rating) and indicates that approximately 60% of the physical bottom of the lake was covered with plants. The mean cover for the littoral zone of the lake was approximately 75% (Shuler et. al., 2004).

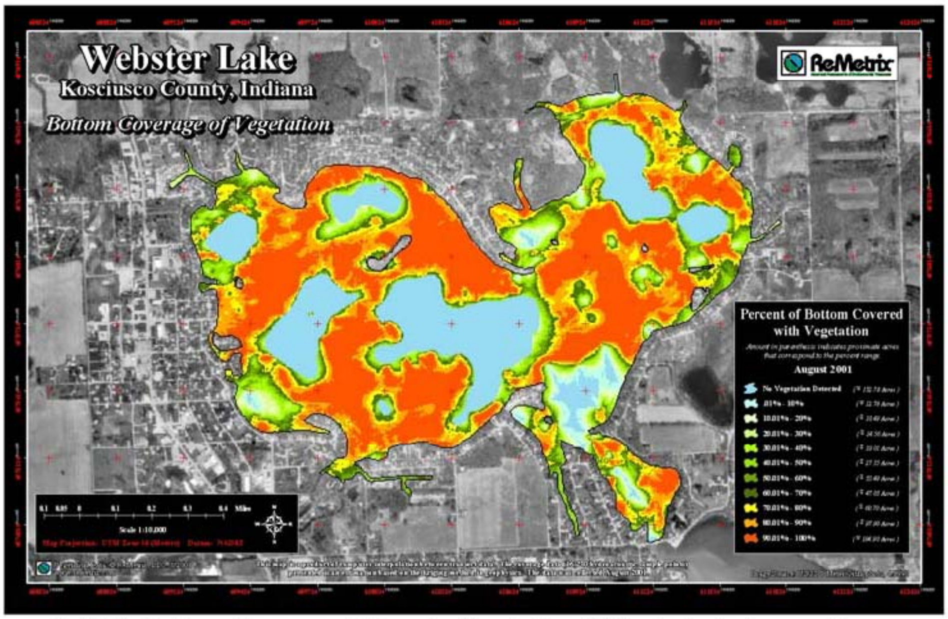

Figure 6. 2001 Bottom Coverage of Aquatic Vegetation, Webster Lake (not to scale see Appendix)

In 2001, biovolume was also determined for the sample points utilized to determine plant coverage (Figure 7). Biovolume data indicated that 428 acres of Webster Lake had more than 10% of the water column filled with plants. Biovolume of greater than 20% was present in 273 acres of the lake at the time of sampling. Biovolume of greater than 30% was present in 112 acres of the lake. The mean biovolume for the lake was 17% while the mean biovolume for the littoral zone was approximately 22%.

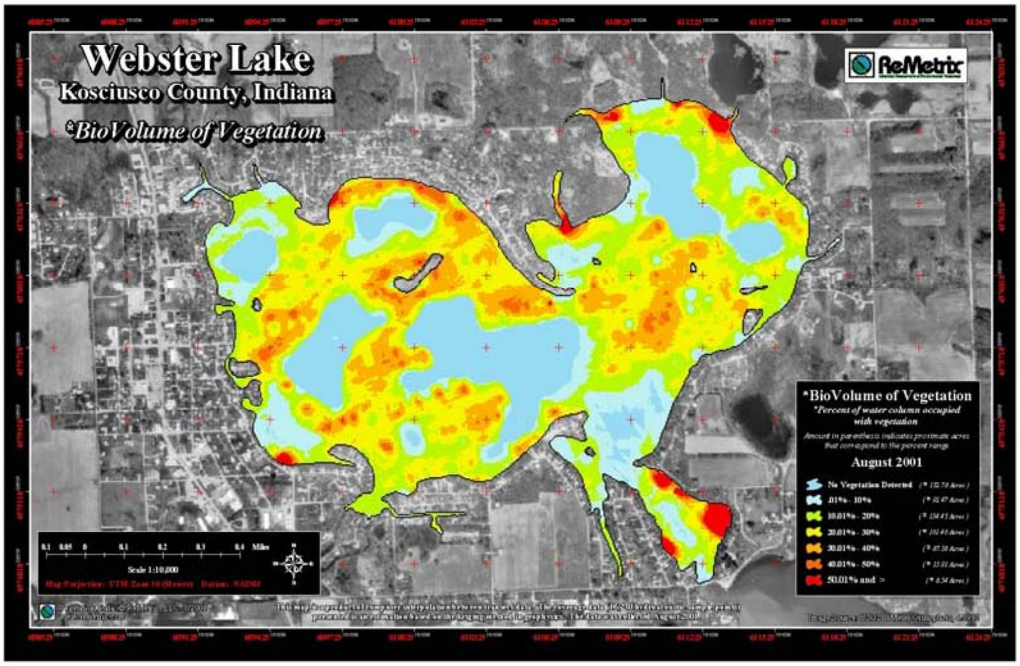

Figure 7. 2001 Biovolume of Aquatic Vegetation, Webster Lake (not to scale see Appendix)

In 2001, point sampling data was collected from 200 sites on Webster Lake (Table 2). Eurasian watermilfoil was the most abundant species collected at 47% of sample sites (Figure 8).

Table 2. Vegetation Point Sample Results for Webster Lake, August 2001

Species	Number of Survey Sites Dense	Common	Sparse	Rare	Total	Percent of Survey Sites
	>60%	20%-60%	3%-20%	<3%		
Curlyleaf pondweed	0	0	7	27	34	17.00%
***Emergent Aquatic Vegetation**	10	0	0	4	14	7.00%
Eurasian Watermilfoil	2	9	31	52	94	47.00%
Large-leaved pondweed	1	3	1	6	11	5.50%
****Submersed Native Aquatic Vegetation**	60	44	26	25	155	77.50%
Total Survey Sites = 200						
*** Species Included:** Arrow Arum, Arrowhead, Bulrush, Cattail, Pickerelweed, Rose Mallow, Purple Loosestrife, Burreed, Spatterdock, and White Waterlily						
****Species Included:** Bladderwort, Coontail, Elodea, Flatstem Pondweed, Long-leaf Pondweed, Chara (Muskgrass), Spiny Naiad, Northern Watermilfoil, Pondweed (*pusillus*), Pondweed (*foliosus*), Sagittaria Ambigua, Sago pondweed, Southern Naiad, Slender (common) Naiad, Brittle Naiad, Variable Pondweed, Large-leaved Pondweed, Water Star Grass, and Whorled Watermilfoil						

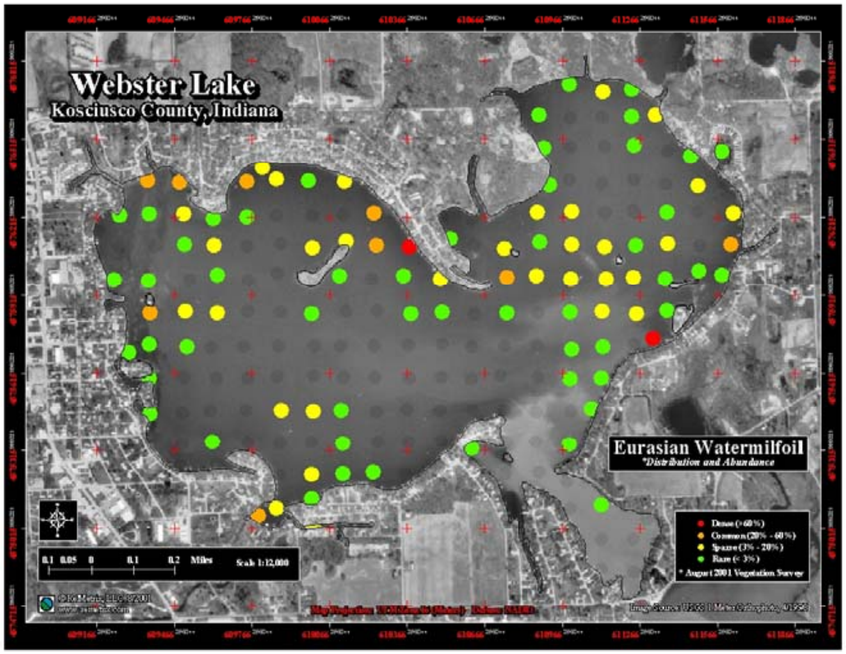

Figure 8. 2001 distribution of Eurasian Watermilfoil, Webster Lake (not to scale see Appendix)

Aquatic Control completed another evaluation of the aquatic vegetation in Webster and Backwater Lake on September 8, 2003. This sampling took place one year after a whole lake fluridone treatment. This sampling used a technique based on a procedure manual developed by Shuler & Hoffmann in 2002. IDNR now refers to this sampling technique as the Tier I survey. Thirteen species of aquatic plants were found during the survey (Table 3). Eurasian watermilfoil was present at only three sites in Backwater Lake and a single site in Webster Lake. The 2002 fluridone treatment significantly reduced the amount of Eurasian watermilfoil in Webster and Backwater Lake one-year post treatment (Shuler, 2003).

Table 3. Aquatic vegetation collected from Webster and Backwater Lake on September 8, 2003.

Common Name	Scientific Name	Frequency of Occurrence
Chara	*Chara spp.*	1%
Common naiad	*Najas flexilis*	4%
Coontail	*Ceratophyllum demersum*	45%
Curlyleaf pondweed	*Potamogeton crispus*	5%
Eurasian watermilfoil	*Myriophyllum spicatum*	1%
Flatstem pondweed	*Potamogeton zosteriformis*	5%
Leafy pondweed	*Potamogeton foliosus*	1%
Northern watermilfoil	*Myriophyllum sibiricum*	<1%
Sago pondweed	*Stuckenia pectinata*	46%
Spatterdock	*Nuphar advena*	10%
Spiny naiad	*Najas marina*	1%
Water star grass	*Zosterella dubia*	7%
White waterlily	*Nymphaea odorata*	5%

Number of species:	13
Mean number of species/site:	1.2
Maximum species/site:	4
Number of sites:	280
Sites with plants:	220 (79%)
Mean diversity:	0.182
Mean Secchi (4 locations):	6.6 ft.
Maximum depth of growth:	9 ft.
Dense sites (>60%):	25 (9%)
Surface pH:	8.1
Surface alkalinity:	171
Surface total phosphorus:	0.16
Surface orthophosphate:	0.03
Surface nitrate-nitrogen:	0.1

In order to gain funding from LARE for exotic plant management activities it was required to adjust sampling techniques to meet LARE requirements. This was required in order to have a consistent sampling protocol which will be used by biologists and lake managers throughout the state. This should reduce confusion and allow for the different organizations to compare sampling data.

Tier I and Tier II sampling was completed on Webster Lake on August 25, 2004. Ideally, two Tier II surveys should be completed in a season in order to document changes in plant community characteristics that occur over the course of the spring through late summer seasons, but due to time limitations a single survey was completed in 2004.

The Tier I survey was developed to serve as a qualitative surveying mechanism for aquatic plants. This survey technique can quickly divide the lake into distinct plant beds.

The Tier I survey is based upon the procedure manual developed by Shuler & Hoffmann, 2002. This survey will serve to meet the following objectives:

1. to provide a distribution map of the aquatic plant species within a waterbody
2. to document gross changes in the extent of a particular plant bed or the relative abundance of a species within a waterbody (IDNR, 2004)

Webster Lake-Tier I survey results

The Tier I survey was completed on August 25, 2004. This survey revealed five distinct plant beds within Webster Lake totaling 336 acres. (Figure 9 & Table 4). Plant beds are defined as contiguous, consistent (similar composition) aquatic plant communities. Vegetation was present to a maximum depth of 12 feet. Plant beds varied widely in size and species diversity.

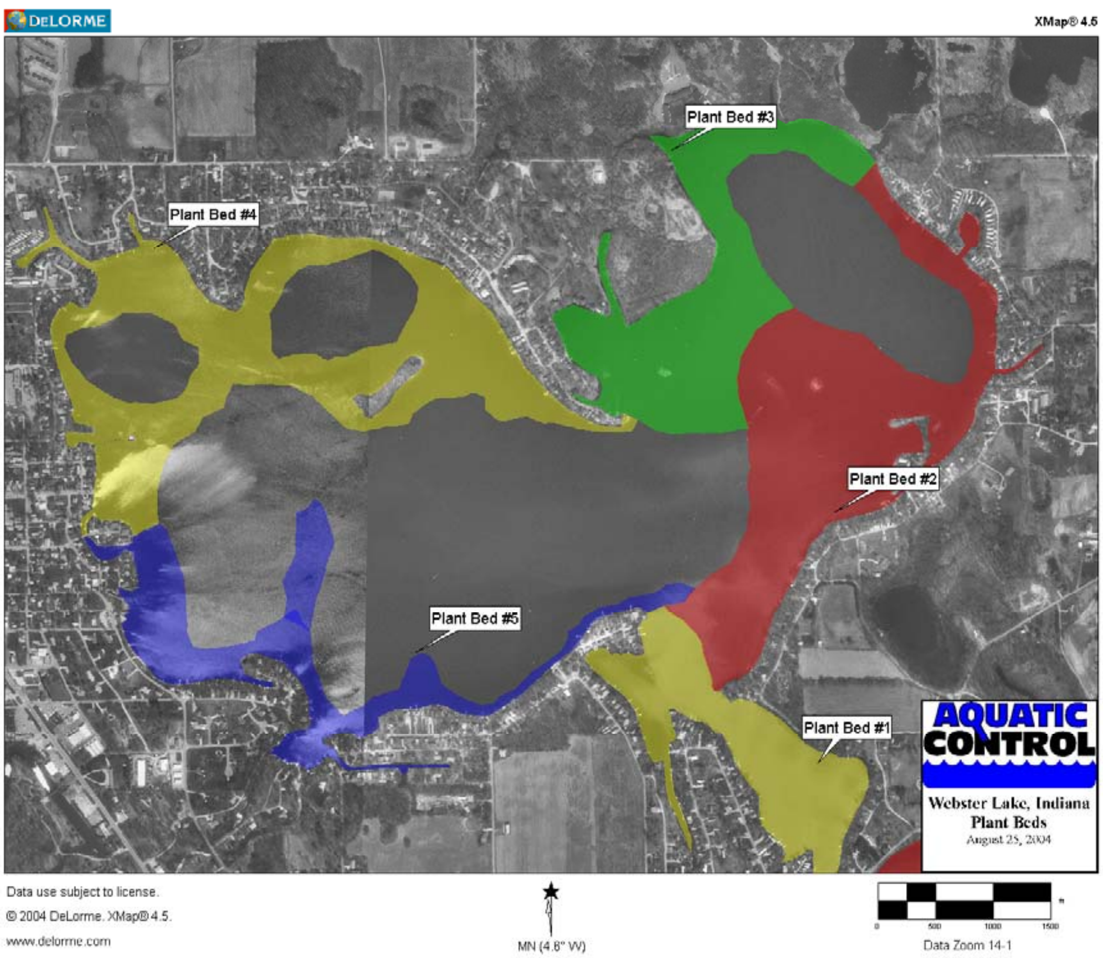

Figure 9. Webster Lake, Tier I plant beds (not to scale see appendix).

Table 4. Webster Lake Tier I Survey Results

Plant Bed I.D.	#1	#2	#3	#4	#5
Plant Bed Size (acres)	42.12	92.29	61.82	94.23	46.07
	Rating*	Rating*	Rating*	Rating*	Rating*
Eurasian watermilfoil**	2	2	2	2	2
Coontail	2	2	-	2	1
Yellow pond lily	1	1	2	1	-
Chara	1	1	3	1	1
Sago pondweed	1	1	-	1	-
Curlyleaf pondweed**	1	1	1	1	1
Flatstem pondweed	1	2	1	2	2
White water lily	1	1	1	-	1
Duckweed	1	1	1	1	1
Slender naiad	1	2	2	2	2
Watermeal	1	1	1	1	1
Richardson's pondweed	-	1	-	-	-
Spiny naiad	-	-	2	-	-
Leafy pondweed	-	-	-	2	-
Illinois pondweed	-	-	-	-	1

*Rating refers to density which is scored from 1-5, 1 being least dense and 5 being most dense
**Exotic Species

Plant bed 1 was determined to be 42.12 acres in size. This plant bed was located in the southern part of the lake and included Webster Bay (Figure 9). The substrate of plant bed 1 was predominantly silt and clay and high in organics. A total of 11 species were observed within the plant bed. Eurasian watermilfoil, coontail, and spatterdock were the dominant plant species (2-20% abundance rating). Chara (*chara sp.)*, sago pondweed (*Stuckenia pectinata)*, curlyleaf pondweed, flatstem pondweed (*Potamogetan zosteriformis)*, white water lily *(Numphaea ordorata)*, duckweed, watermeal (*Wolfia sp.)* and slender naiad (*Najas flexilis)* were present at the lowest abundance rating (less than 2%). Aquatic vegetation reached the surface and created a canopy in 2-20% of the plant bed area.

Plant bed 2 was located northeast of plant bed 1 and determined to be 92.29 acres (Figure 9). The substrate of plant bed 2 was silt with sand and high in organics. A total of 11 species were observed within the plant bed. Eurasian watermilfoil, coontail, flatstem pondweed, and slender naiad were the dominant species (2-20% abundance rating). Chara, sago pondweed, curlyleaf pondweed, duckweed, watermeal, spatterdock, and Richardson's pondweed (*Potamogetan richardsonii)* were present at the lowest abundance rating (less than 2%). Less than 2% of the plant bed contained plants which reached the surface and created a canopy.

Plant bed 3 was located west of plant bed 2 and was determined to be 61.82 acres (Figure 9). The substrate of plant bed 3 was silt with sand and high in organics. A total of 11 species were observed within the plant bed. Chara was the most abundant species present (21-60% abundance) followed by spiny naiad (*Najas marina)*, Eurasian watermilfoil, slender naiad, and spatterdock at 2-20% abundance. Curlyleaf pondweed, flatstem pondweed, duckweed, white water lily, and watermeal were present at the lowest abundance rating (less than 2%). Between 2-20% of the plant bed was dominated by vegetation which reached the surface and formed a canopy.

Plant bed 4 was located west of plant bed 3 and encompassed the two islands in this area (Figure 9). This plant bed was determined to be 94.23 acres. The substrate of plant bed 4 was sand. A total of 12 species were observed within the plant bed. Eurasian watermilfoil, coontail, flatstem pondweed, leafy pondweed *(Potamogetan foliosus)*, and slender naiad were the most abundant species observed (2-20% abundance rating). Chara, sago pondweed, curlyleaf pondweed, watermeal, duckweed, water stargrass, and spatterdock were present at less than 2% abundance. Vegetation reached the surface and created a canopy in 2-20% of the plant bed area.

Plant bed 5 was located in the southwest corner and encompassed 46.07 acres (Figure 9). The substrate of plant bed 5 was predominantly sand. A total of 11 species were observed within the plant bed. Eurasian watermilfoil, flatstem pondweed, slender naiad, and water stargrass (*Zosterella dubia)* were the most abundant species observed (2-20% abundance rating). Chara, curlyleaf pondweed, coontail, duckweed, watermeal, and Illinois pondweed (*Potamogeton illinoensis)* were present at less than 2% abundance. Vegetation reached the surface and created a canopy in 2-20% of the plant bed area.

Webster Lake Tier II Survey Results

Creation of the aquatic vegetation management plan also requires sampling to quantify the occurrence, distribution, and abundance of aquatic vegetation. This type of survey will be referred to as the Tier II survey. This protocol is currently being used by the IDNR Division of Fish and Wildlife to provide a quantitative sampling mechanism for aquatic plant surveying. This protocol supplements the Tier I Reconnaissance Protocol for plant bed mapping. Together the protocols should serve to meet the following objectives:

1. to document the distribution and abundance of submersed and floating-leaved aquatic vegetation
2. to compare present distribution and abundance with past distribution and abundance within select areas (IDNR, 2004).

All of the data which was collected through the use of this protocol was recorded on standardized data sheets and put into table form (Appendix C). The data collected was compared to data collected by IDNR District fisheries biologist Jed Pearson, which is presented in his 2004 paper "A Sampling Method to Assess Occurrence, Abundance, and Distribution of Submersed Aquatic Plants in Indiana Lakes". In this paper, Pearson used 21 northern Indiana lakes to calculate various aquatic plant abundance and diversity metrics (Pearson, 2004). The sampling procedure outlined in Pearson's paper was used to calculate these same metrics for Webster Lake. The data collected will also be valuable for future comparison, which will document changes in the plant community following proposed management activities.

A total of 160 sample sites were randomly selected within the littoral zone of Webster Lake (Figure 10). Once a site was reached the boat was slowed to a stop and the coordinates were recorded on a hand-held GPS unit and later downloaded into a mapping program. A depth measurement was taken by dropping a two-headed standard sampling rake that was attached to a rope marked off in 1-foot increments (Figure 11). An additional ten feet of rope was released and the boat was reversed at minimum operating speed for a distance of ten feet. Once the rake is retrieved the overall plant abundance on the rake is scored from 1-5 and then individual species are placed back on the rake and scored separately (the rake is marked off in 5 equal sections on the tines).

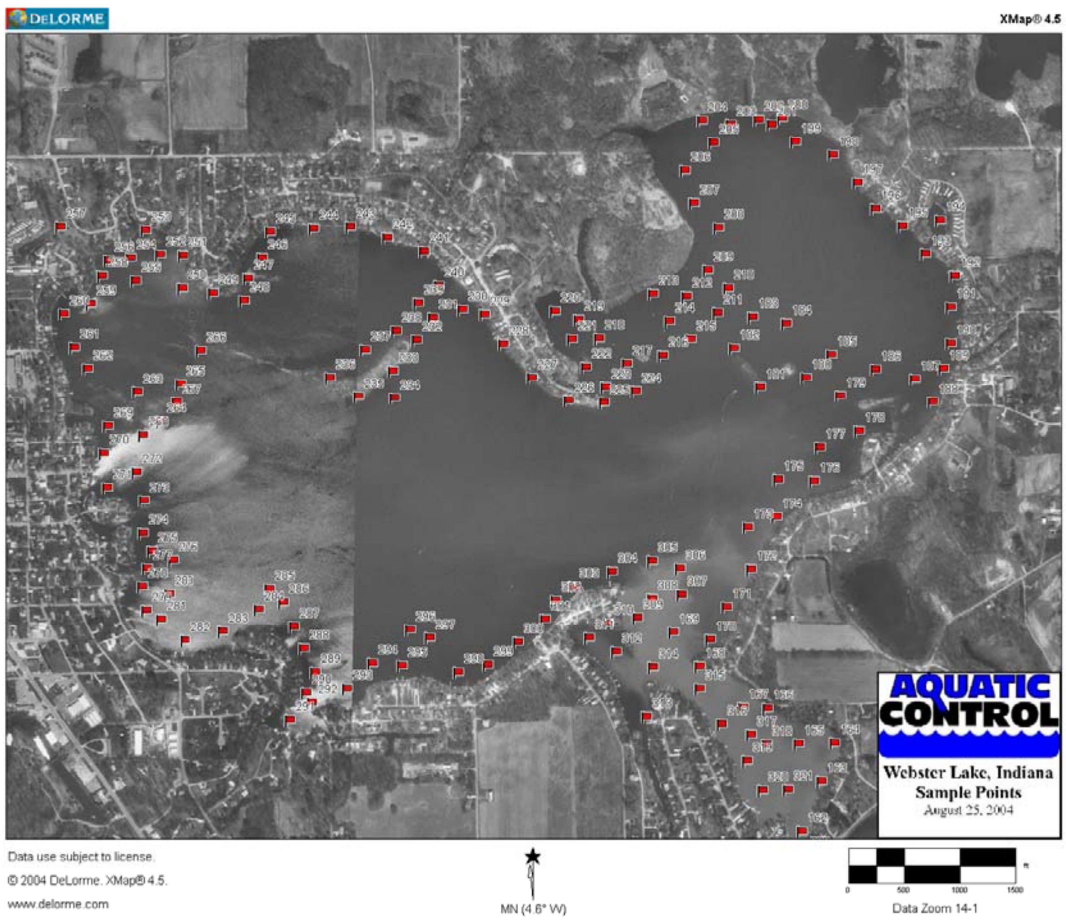

Figure 10. Tier II Sample points (not to scale see appendix).

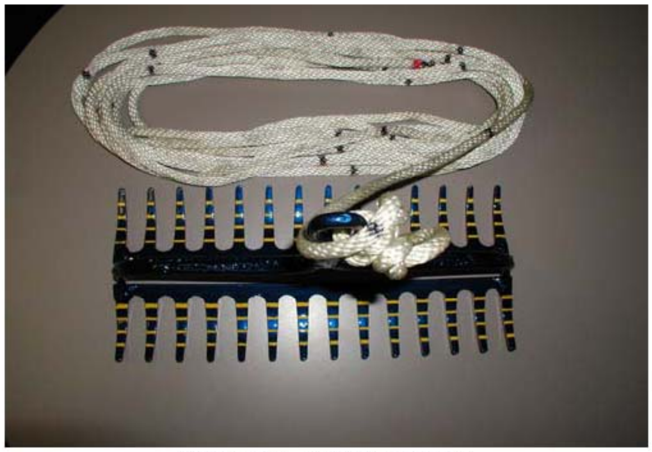

Figure 11. Sampling Rake

Tier II sampling took place on August 25, 2004 immediately following the Tier I sampling. A Secchi disk reading was taken prior to sampling and was found to be 5 feet. Plants were present to a maximum depth of 12 feet. Figure 12 illustrates aquatic vegetation distribution and abundance in Webster Lake. The mean depth from which samples were taken was 5.73 feet. Aquatic vegetation was present at 79% of littoral sample sites. The mean rake density score for Webster Lake was 1.84. Species richness (average number of species per site) was 1.54 for all species and 1.20 for natives only. Site species diversity index was 0.85 for all species and 0.80 for native species only. Webster Lake had a rake diversity score of 0.85 for all species and 0.81 for natives only. This data was compared to data collected by IDNR District fisheries biologist Jed Person on July 31, 2003 (Table 5). The comparison indicated Webster Lake had an increased diversity and abundance of native plant species in 2004.

Table 5. August 25, 2004 Webster Lake vegetation abundance, density, and diversity metrics compared to July 28, 2003.

	Webster Lake*	Webster July 2003**
Percentage of littoral sites with plants	79%	55%
# of species collected	13	7
# of native species collected	10	6
Mean Rake Density	1.84	2.70
Rake Diversity (RDI)	0.85	0.66
Native Rake Diversity (RDI)	0.81	0.59
Species Richness (Avg # spec./site)	1.54	0.68
Native Species Richness	1.20	0.56
Site Species Diversity	0.85	0.73
Site Species native diversity	0.80	0.65

*standard deviation not included
**Pearson July 2003 Webster sampling

During the Tier II survey a total of 13 species were collected of which 10 of the species were natives. Eurasian watermilfoil and curlyleaf pondweed were the exotic species collected. Coontail was present in the highest percentage of sample sites (36.9%) (Figure

13), followed by flatstem pondweed (29.4%) (Figure 14), slender naiad (22.5%), curlyleaf pondweed (21.3%) (Figure 15), Eurasian watermilfoil (12.5%) (Figure 16), chara (11.3%) (Figure 17), small pondweed (*Potamogetan pusillus*) (7.5%) (Figure 18), water stargrass (5.6%), sago pondweed (3.8%) (Figure 19), spiny naiad (1.9%), and nitella (*nitella sp.*)(1.3%). Illinois pondweed and American elodea (*Elodea canadensis*) were collected at a single site (Table 6). Figure 20 illustrates the changes in Eurasian watermilfoil frequency of occurrence over the past four surveys.

Table 6. Species collected during Tier II sampling.

Common Name	Scientific Name	Frequency of Occurrence	Relative Density*	Dominance Index**
Coontail	*Ceratophyllum demersum*	36.90%	0.53	12.3
Flatstem pondweed	*Potamogeton zosteriformis*	29.40%	0.46	9.1
Slender naiad	*Najas flexiilis*	22.50%	0.45	9.0
Curlyleaf pondweed	*Potamogeton crispus*	21.30%	0.23	4.6
Eurasian watermilfoil	*Myriophyllum spicatum*	12.50%	0.15	3.0
Chara	*Chara sp.*	11.30%	0.23	4.5
Small pondweed	*Potamogeton pusillus*	7.50%	0.13	2.5
Water stargrass	*Zosterella dubia*	5.60%	0.06	1.3
Sago pondweed	*Potamogeton pectinatus*	3.80%	0.07	1.4
Spiny naiad	*Najas marina*	1.90%	0.08	1.3
Nitella sp.	*Nitella sp.*	1.30%	0.01	0.3
Illinois pondweed	*Potamogeton illinoensis*	0.06%	0.01	0.3
American elodea	*Najas flexilis*	0.06%	0.01	0.3

*Mean rake score at all sites
**Percent of maximum abundance

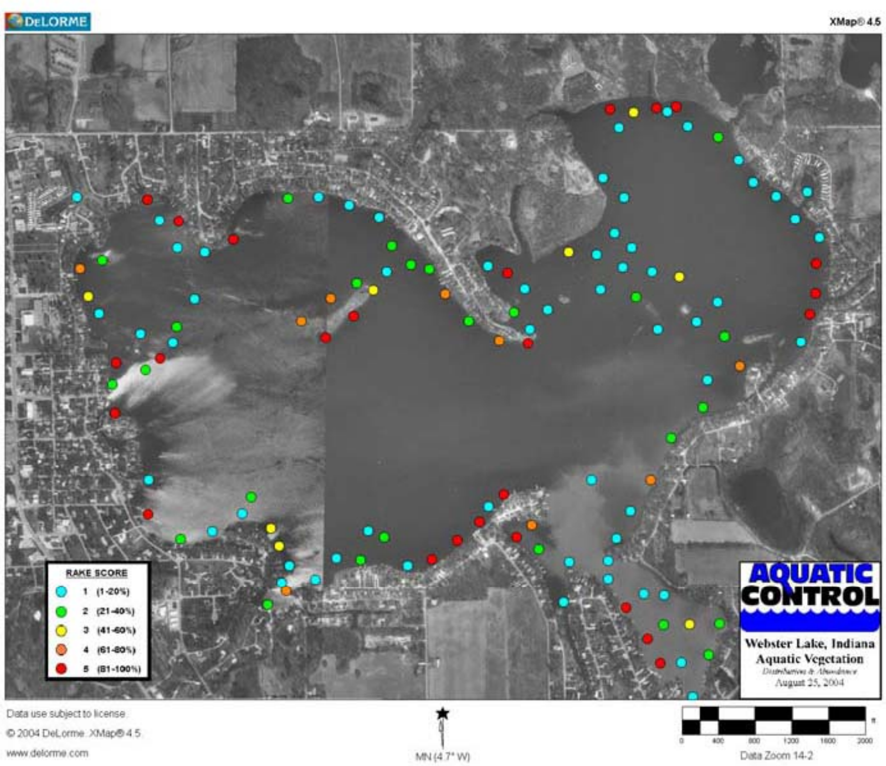

Figure 12. Aquatic vegetation distribution and abundance (not to scale see appendix)

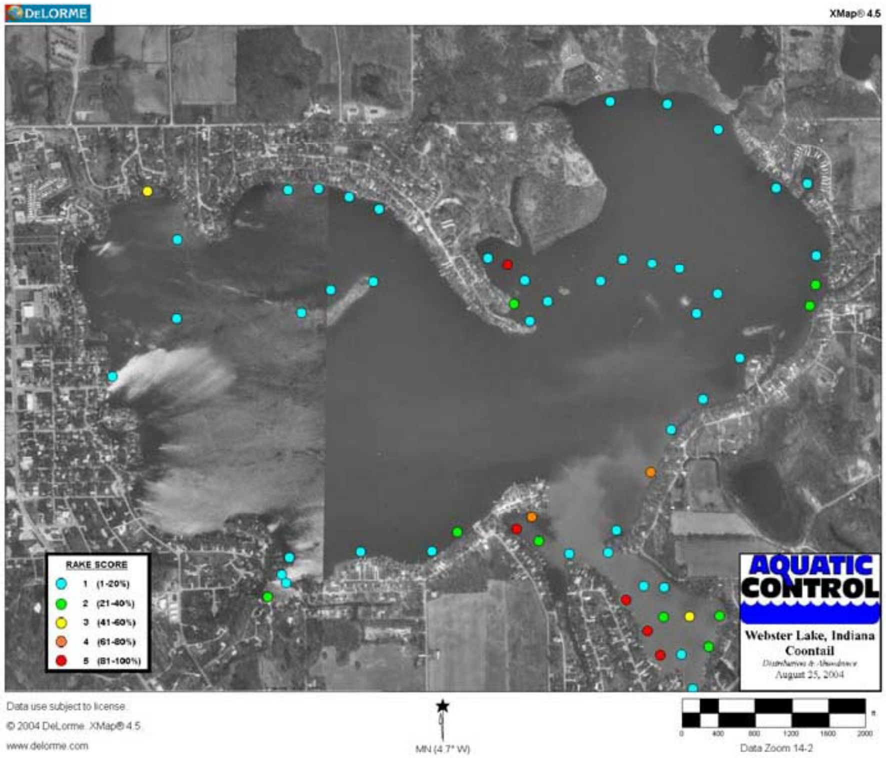

Figure 13. Coontail distribution and abundance (not to scale see appendix)

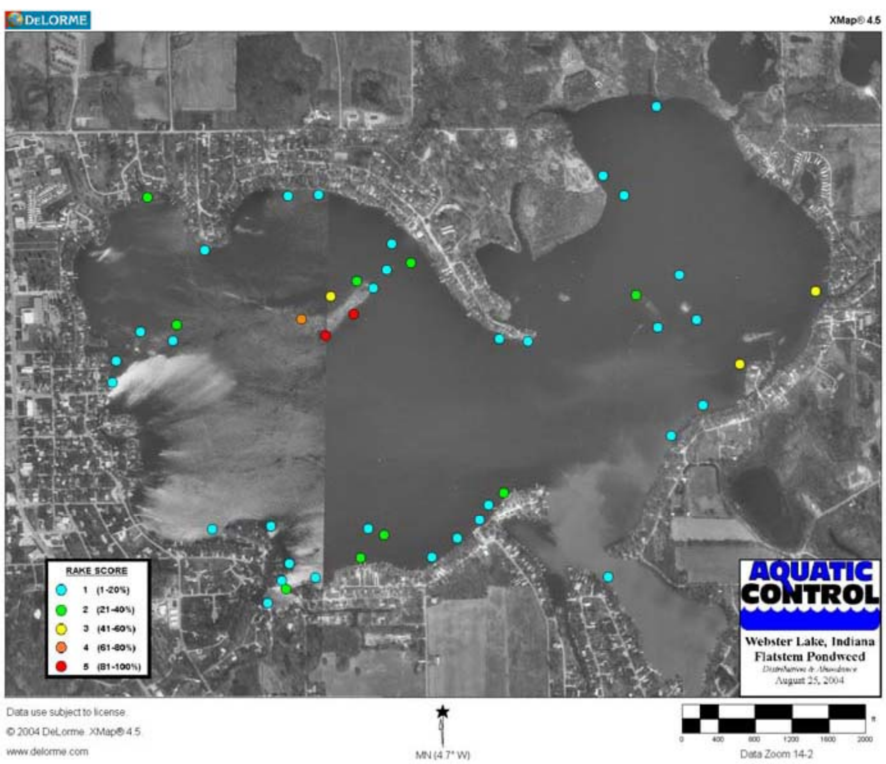

Figure 14. Flatstem pondweed distribution and abundance (not to scale see appendix)

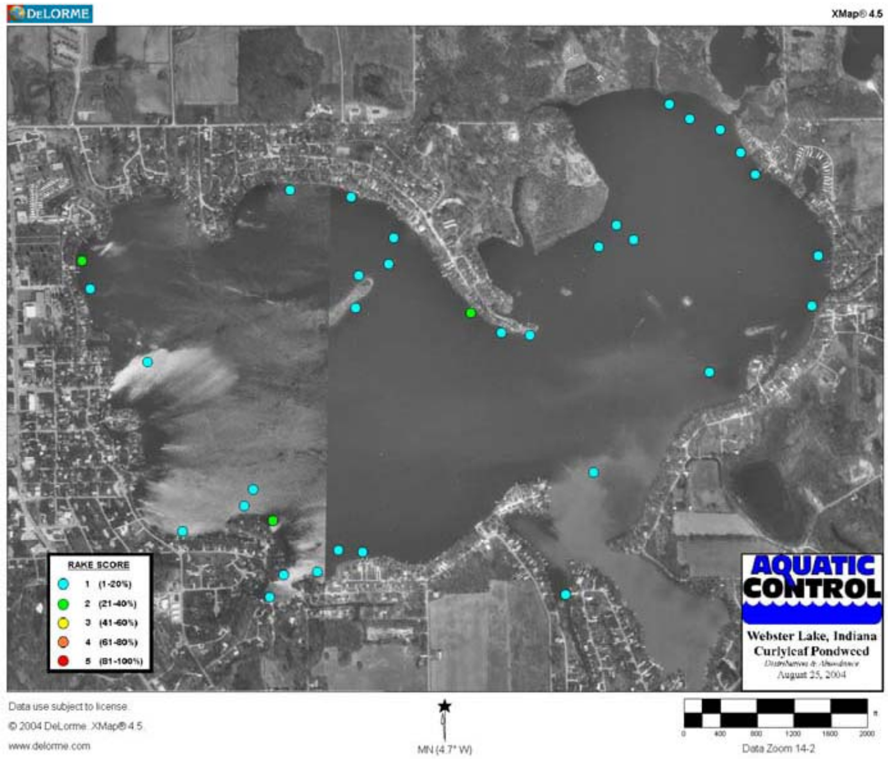

Figure 15. Curlyleaf pondweed distribution and abundance (not to scale see appendix)

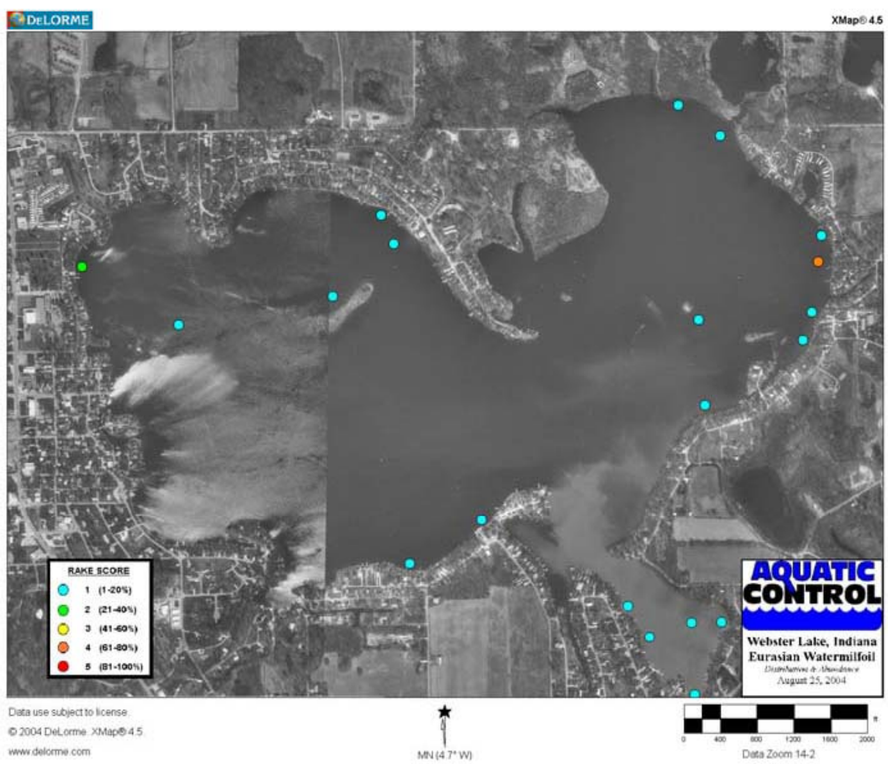

Figure 16. Eurasian watermilfoil distribution and abundance (not to scale see appendix)

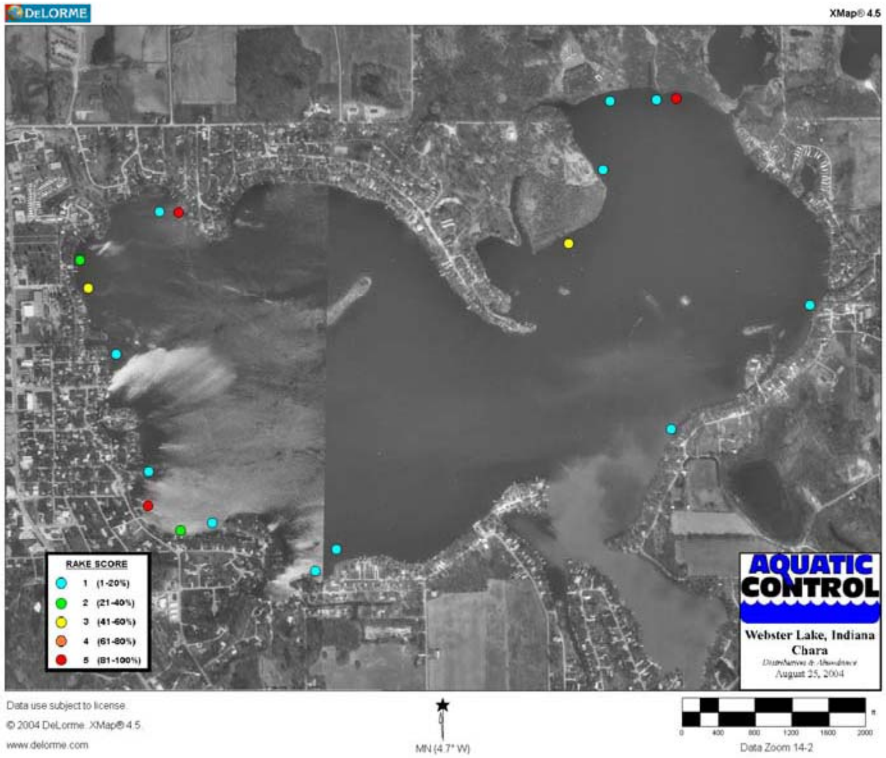

Figure 17. Chara distribution and abundance (not to scale see appendix)

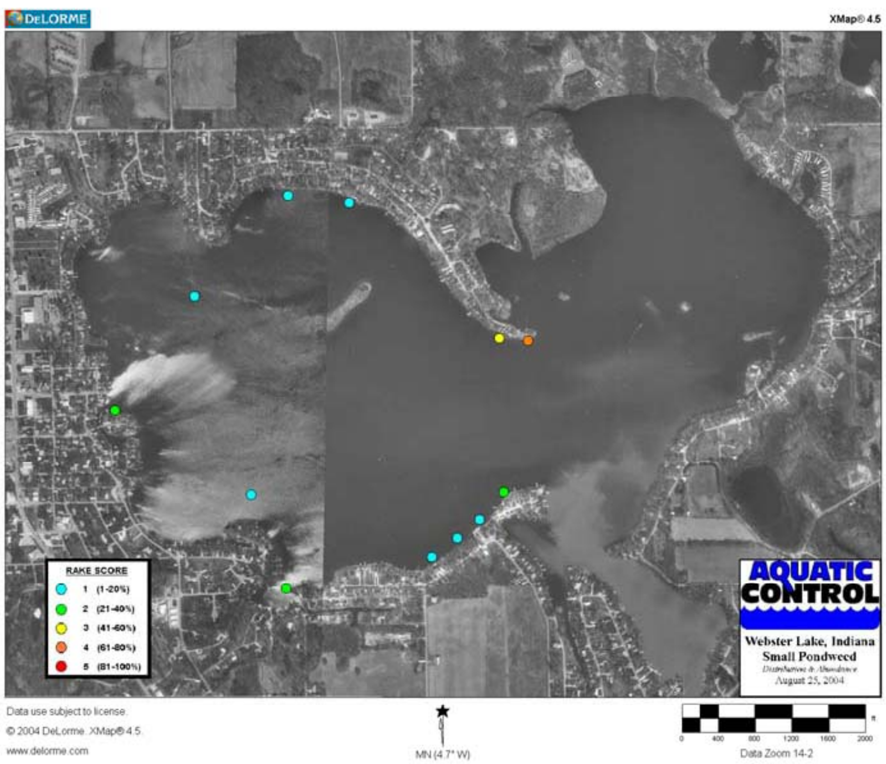

Figure 18. Small pondweed distribution and abundance (not to scale see appendix)

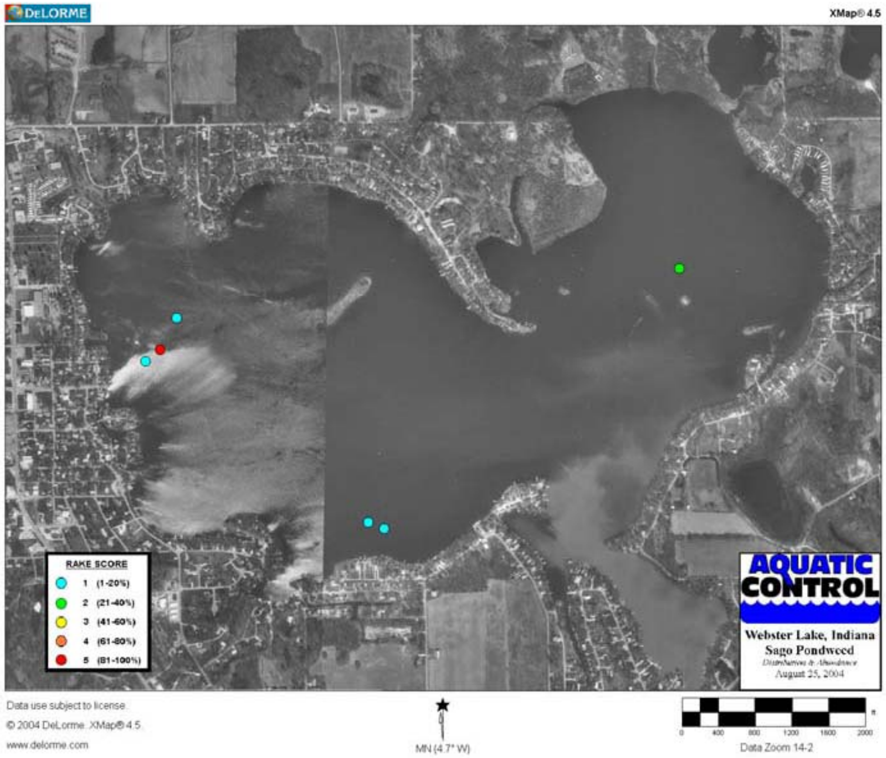

Figure 19. Sago pondweed distribution and abundance (not to scale see appendix)

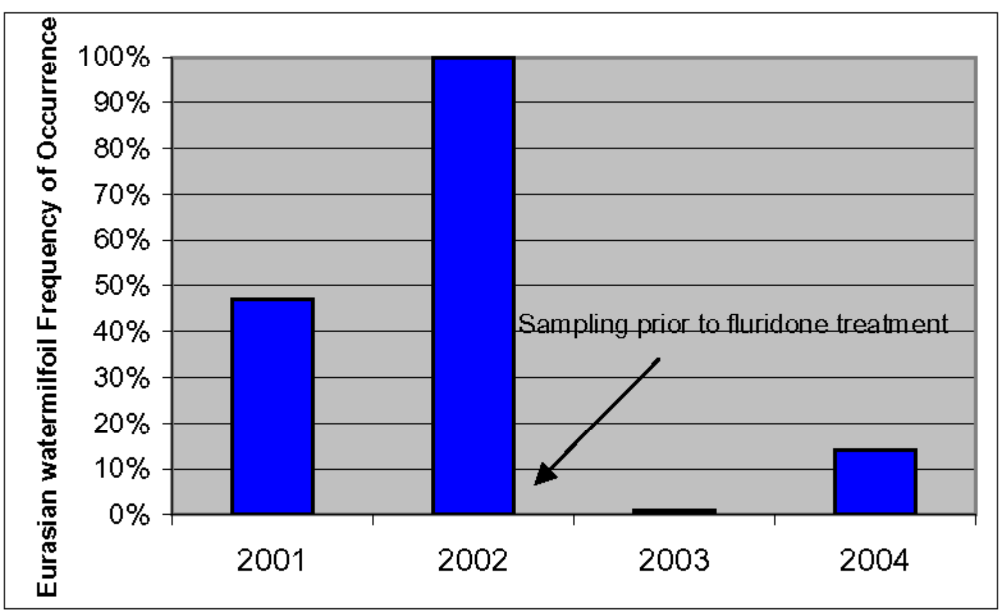

Figure 20. Eurasian watermilfoil frequency of occurrence for the past four years (various survey techniques used).

Backwater Lake-Tier I survey results

Backwater Lake was included in the 2004 sampling. The Tier I survey was completed on August 25, 2004. The Tier I survey revealed two distinct plant beds within Backwater Lake totaling 190 acres. (Table 7 & Figure 21).

Table 7. Backwater Lake Tier I Survey Results

Plant Bed I.D.	#1	#2
Plant Bed Size (acres)	73.94	63.33
	Rating*	Rating*
Eurasian watermilfoil**	1	2
Coontail	2	2
Yellow pond lily	2	2
Curlyleaf pondweed**	-	1
White water lily	1	1
Duckweed	1	2
Watermeal	1	2

*Rating refers to density which is scored from 1-5, 1 being least dense and 5 being most dense
**exotic species

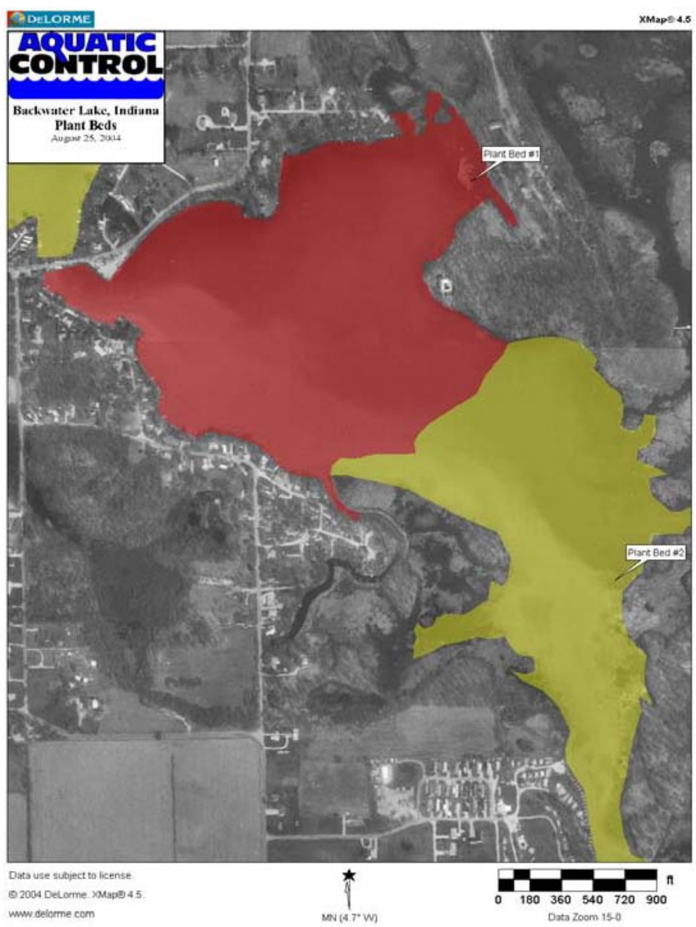

Figure 21. Backwater Lake, Tier I plant beds (not to scale see appendix).

Plant bed 1 was determined to be 73.94 acres in size. This plant bed was located in the northern part of the lake. The substrate of plant bed 1 was predominantly silt with sand and high in organics. A total of 6 species were observed within the plant bed. Coontail and yellow pond lily were the dominant plant species (2-20% abundance rating). Eurasian watermilfoil, duckweed, watermeal, and white water lily were present at the lowest abundance rating (less than 2%). Aquatic vegetation reached the surface and created a canopy in 2-20% of the plant bed area.

Plant bed 2 was determined to be 63.33 acres in size. This plant bed was located in the southern part of the lake. The substrate of plant bed 2 was predominantly silt with sand and high in organics. A total of 7 species were observed within the plant bed. Coontail, yellow pond lily, Eurasian watermilfoil watermeal, and duckweed were the dominant plant species (2-20% abundance rating). White water lily and curlyleaf pondweed were present at the lowest abundance rating (less than 2%). The majority of the plant bed was covered with canopy forming vegetation (floating rooted 21-60%, submersed 2-20%, emergent 2-20%).

Backwater Lake Tier II Survey Results

Tier II sampling took place on August 25, 2004 immediately following the Tier I sampling. A total of 42 sites were sampled (Figure 22). A Secchi disk reading was taken prior to sampling and was found to be 2 feet. Plants were present to a maximum depth of 6 feet. A total of 4 species were collected of which 2 of the species were natives. The mean depth from which samples were taken was 3.90 feet. Aquatic vegetation was present at 86% of littoral zone sampling sites. The mean rake density score for Backwater Lake was 3.90. Species richness (average number of species per site) was 0.95 for all species and 0.76 for natives only. Site species diversity index was 0.49 for all species and 0.29 for native species only. Backwater Lake had a rake diversity score of 0.55 for all species and 0.41 for natives only (Table 8). Backwater Lake has below average plant abundnance, diversity, and density when compared to average. Aquatic Control biologists observed more dense plant beds in 2003. The reason for the reduction is not clear.

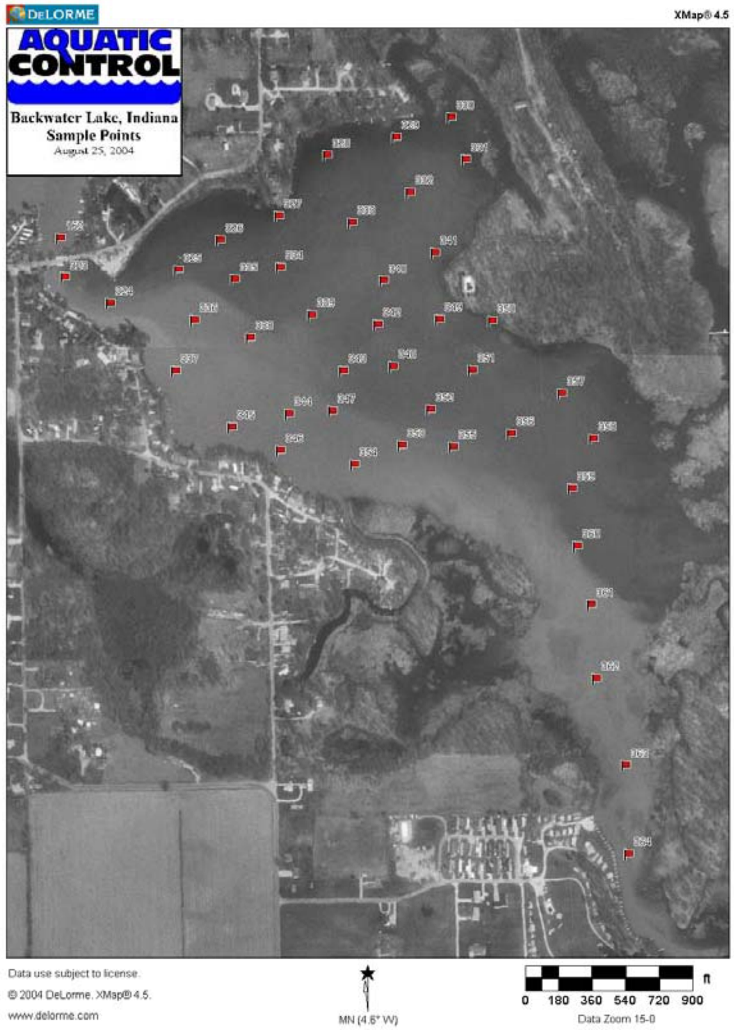

Figure 22. Backwater Lake, August 25, 2004 sampling points (not to scale, see appendix)

Table 8. August 25, 2004 Backwater Lake vegetation abundance, density, and diversity metrics compared to average

	Backwater Lake*	Average**
Percentage of littoral sites with plants	86%	-
# of species collected	4	8
# of native species collected	2	7
Mean Rake Density	2.33	3.30
Rake Diversity (RDI)	0.55	0.62
Native Rake Diversity (RDI)	0.41	0.50
Species Richness (Avg # spec./site)	0.95	1.61
Native Species Richness	0.76	1.33
Site Species Diversity	0.49	0.66
Site Species native diversity	0.29	0.56

*standard deviation not included
**Calculated from Pearson 2003 sampling of 21 northern Indiana lakes

Eurasian watermilfoil and curlyleaf pondweed were the exotic species collected. Figure 23 illustrates the overall aquatic vegetation distribution and abundance. Coontail was present in the highest percentage of sample sites (76.2%) (Figure 24), followed by Eurasian watermilfoil (12.5%) (Figure 25), nitella (12.5%) (Figure 26), and curlyleaf pondweed (2.4%) (Figure 27) (Table 9).

Table 9. Backwater Lake species collected during Tier II sampling.

Common Name	Scientific Name	Frequency of Occurrence	Relative Density*	Dominance Index
Coontail	*Ceratophyllum demersum*	76.20%	1.57	31.4
Eurasian watermilfoil	*Myriophyllum spicatum*	16.70%	0.33	6.7
Nitella sp.	*Nitella sp.*	16.70%	0.64	12.9
Curlyleaf pondweed	*Potamogeton crispus*	2.40%	0.02	0.5

*Mean rake scores at all sites
**Percent of maximum abundance

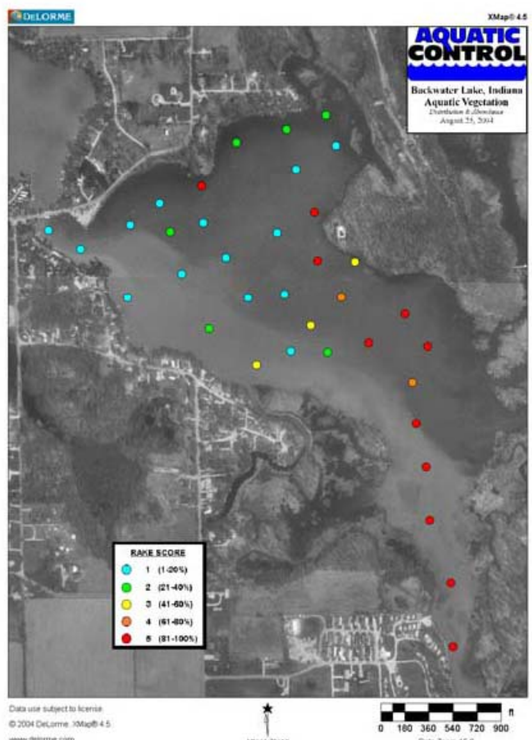

Figure 23. Backwater Lake, aquatic vegetation distribution and abundance (not to scale, see appendix)

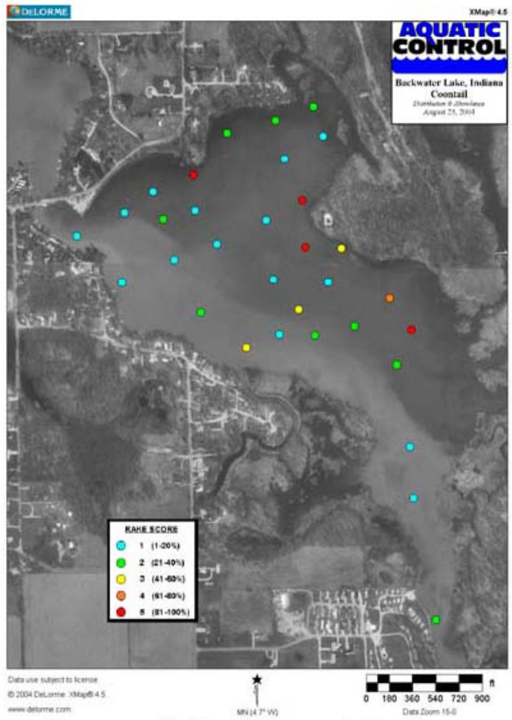

Figure 24. Backwater Lake, coontail distribution and abundance (not to scale, see Figure 25.

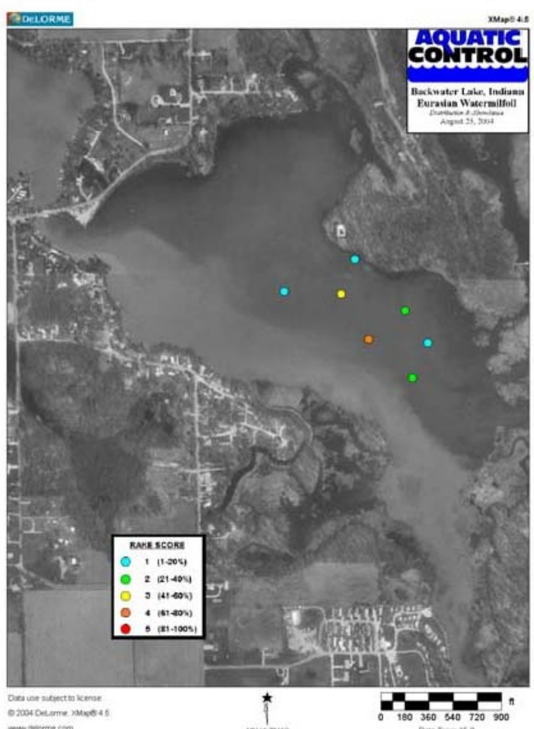

Figure 25. Backwater Lake, Eurasian watermilfoil distribution and abundance (not to scale, see appendix)

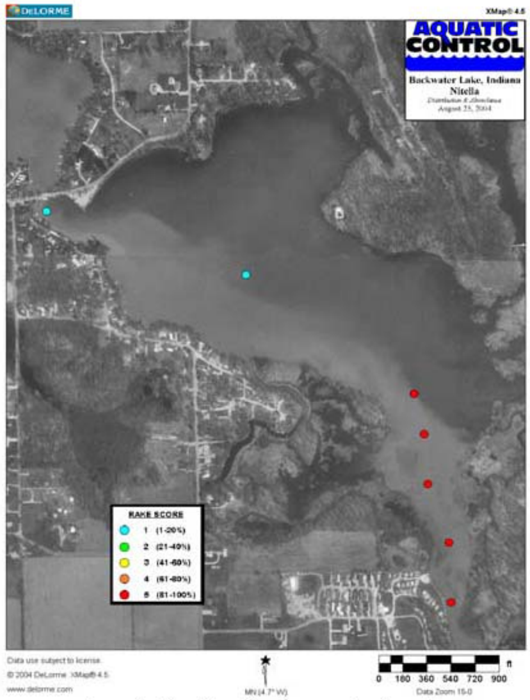

Figure 26. Backwater Lake, nitella distribution and abundance (not to scale, see appendix)

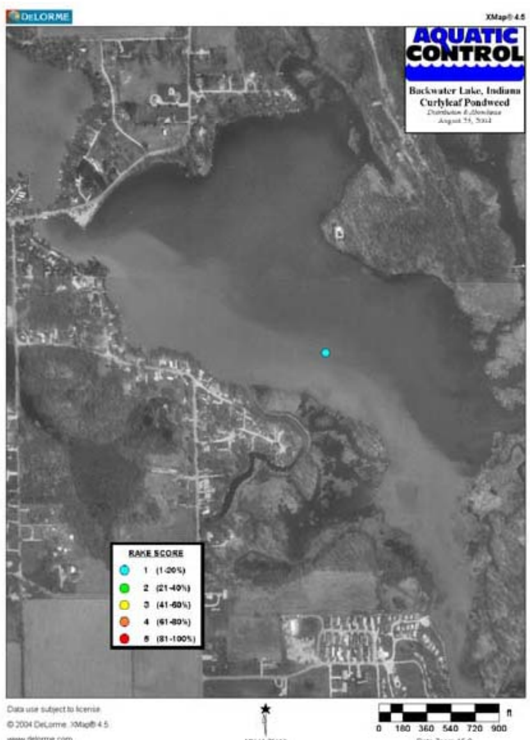

Figure 27. Backwater Lake, curlyleaf pondweed distribution and abundance (not to scale, see appendix)

Plant Management History

Webster Lake has been treated on an annual basis since at least 1982 (Table 10). Past treatment information indicates treatment areas have ranged from 32.5 acres to whole lake applications. Species that have been permitted for control include: milfoil, Eurasian watermilfoil, mixed pondweeds, water lily, filamentous algae, Chara, naiads, eel grass, elodea, flatstem pondweed, curlyleaf pondweed, and coontail. A variety of herbicides have been used in the past including: Reward, Aquathol K, Hydrothol 191, copper sulfate, Sonar 5P, Sonar AS, Sonar SRP, Sonar PR, granular 2,4-D, and Nautique. In recent years, approximately 60 acres have been treated with contact herbicides. Eurasian watermilfoil has typically been the primary target for control. Curlyleaf pondweed and coontail have been additional species that have been targeted in recent years.

Table 10. Webster Lake Treatment and Permit History

	Targeted Vegetation	Acreage Approved	Treated Acres	Chemical Approved	Total Cost	Per Acre Cost
1982	Milfoil, Pondweeds, Lily Pads and Filanmentous Algae	*	*	Reward, Aquathol, 2,4-D, CuSO4	10,000.00	*
1983	Pondweeds, Milfoil, Chara, and Filamentous Algae	90	*	Reward, Aquathol, 2,4-D, CuSO4	*	*
1984	Pondweeds, Milfoil, Eel Grass, Naiad, Chara, and Filamentous Algae	83	65	Reward, Hydrothol, Komeen, CuSO4, and Aquathol K	12,000.00	185.00
1985	Milfoil, Naiad, Chara, Pondweeds, and Filamentous Algae	83	73	Reward Komeen, AquatholK, and CuSO4	13,140.00	180.00
1986	Watermilfoil, Pondweeds, Naiads, Eel Grass, Chara, and Filamentous Algae	73	*	Reward, Aquathol K, Komeen, Hydrothol, CuSO4	15,000.00	165.00
1987	Milfoil, Pondweed, Eel Grass, Elodea, Chara, and Filamentous Algae	*	*	Reward, 2,4-D, Aquathol K, Hydrothol, CuSO4, and Komeen	14,850.00	175.00
1988	Milfoil, Pondweeds, Naiad, Eel Grass, and Algae	*	*	Reward, Komeen, Aquathol K, Hydrothol, Sonar AS, CuSO4	20,527.00	200.00
1989	Watermilfoil, Pondweeds, Chara, and Filamentous Algae	*	*	Reward, Komeen, Aquathol K, Hydrothol, Sonar, CuSO4, and Cidekick	18,185.00	*
1990	Watermilfoil, Mixed Pondweeds, Chara, and Filamentous Algae	*	*	Reward, Komeen, Aquathol, and CuSO4	12,080.00	200.00
1991	Milfoil, Flatstem Pondweed, Curlyleaf Pondweed, Chara, and Filamentous Algae	89	*	Reward, Aquathol K, Komeen, and CuSO4	18,000.00	200.00
1992	Watermilfoil, Mixed Pondweeds, Chara, and Filamentous Algae	*	*	Reward, Komeen, Aquathol K, Sonar, and CuSO4	18,050.00	*
1993	Eurasian WaterMilfoil, Coontail, Pondweeds, and Chara	65	65	Sonar, Aquathol K, Hydrothol, Reward, and CuSO4	19,400.00	300.00
1994	Eurasian Watermilfoil, Coontail, Mixed Pondweeds, Chara, and Filamentous Algae	57	32.5	Reward, Komeen, Aquathol K, Hydrothol, and CuSO4	10,125.00	312.00

1995	Eurasian Watermilfoil, Mixed Milfoil, Coontail, Pondweeds, Elodea, and Chara	60	*	Reward Komeen, AquatholK, and CuSO4	13,230.00	*
1996	Eurasian Watermilfoil	60	60	2,4-D	*	*
1997	Eurasian Watermilfoil	60	60	Reward	*	*
1998	Eurasian Watermilfoil	60	60	Reward	*	*
1999	Eurasian Watermilfoil, Pondweeds, Coontail, and chara	174	174	Sonar SRP, Nautique, Reward, and CuSO4	75,367.00	433.00
2000	Eurasian Watermilfoil, Curlyleaf pondweed, Coontail, Chara, and Filamentous Algae	65	48	Reward, Nautique, Navigate, Aquathol K, and Copper Sulfate	19,585.00	408.00
2001	Eurasian Watermilfoil, Curlyleaf pondweed, Coontail, Chara, and Filamentous Algae	65	65	Reward, Nautique, Navigate, Aquathol K, and Copper Sulfate	23,695.00	364.00
2002	Eurasian Watermilfoil, Curlyleaf pondweed, Coontail, Chara, and Filamentous Algae	653	653	Sonar SRP, Sonar PR, Sonar AS, Nautique, and Copper Sulfate	73,390.00	244.63**
2003	Eurasian Watermilfoil, Curlyleaf pondweed, Coontail, Chara, and Filamentous Algae	65	28	Reward, Nautique, Navigate, Aquathol K, and Copper Sulfate	6,601.00	235.75
2004	Eurasian Watermilfoil, Curlyleaf pondweed, Coontail, Chara, and Filamentous Algae	65	35.75	Reward, Nautique, Navigate, Aquathol K, and Copper Sulfate	11,575.00	322.10**

***insufficient data, ** per acre of control**

In 1999, a selective control treatment was completed using Sonar SRP (slow release pellets). This treatment was completed by applying Sonar aquatic herbicide to 174 acres of the lake with a goal of achieving control of all Eurasian watermilfoil within the entire lake. The treatment program consisted of three separate applications of 3 ppb (parts-per-billion) Sonar to the treatment areas beginning in early May and concluding in early June. Control of nearly all of the Eurasian watermilfoil was achieved by mid-July of 1999. Excellent control of the Eurasian watermilfoil was maintained throughout 2000 and into 2001. Eurasian watermilfoil plants began to spread and appear in more places throughout the lake in 2001. The Eurasian watermilfoil had once again spread throughout the lake by August of 2001 but had not achieved dense beds in many areas. However, as documented earlier, by November of 2001 the plant had formed large dense topped out beds on approximately 255 acres of the lake. Informal surveys conducted by Aquatic Control between the summer of 1999 and spring of 2001 documented the expansion of some species such as flatstem pondweed, water star grass, large-leaf pondweed, and sago pondweed.

In 2000, a contact herbicide treatment was completed on 34 acres in late May to near-shore dock and swimming areas. The primary target within these areas was curlyleaf pondweed and coontail. An algae treatment was completed on 50 acres in June for control of Chara. A second herbicide application was made to 14 acres of weeds in August of 2000. The goal of this treatment was the suppression of nuisance beds of coontail in near-shore areas.

In 2001, a contact herbicide treatment was completed on 46 acres in late May to near-shore dock and swimming areas. The primary target within these areas was curlyleaf pondweed and coontail. An additional 13 acres were treated in late June. This treatment targeted areas that developed nuisance conditions after the May treatment was completed. An algae treatment was completed on 37 acres in July for control of Chara.

In 2002, a Sonar treatment program was completed based upon the findings of the August 2001 mapping survey, the November 2001 survey, and the desires of the Webster Lake Conservation Association. The primary goal of the treatment program was to selectively control Eurasian watermilfoil. Fragments from Backwater Lake may have been the primary source of reinfestation of Eurasian watermilfoil into Webster Lake following the 1999 Sonar treatment. Although Eurasian watermilfoil was determined to be present at only 7.5% of sample sites in Backwater it is common in the main boating channel through this area. Heavy boat traffic continually cuts the milfoil plant tops resulting in many fragments of the growing tips of this plant. This provides a steady flow of these fragments into Webster Lake giving rise to re-infestation in Webster Bay and other areas of Webster Lake. In an effort to reduce this source of fragments of Eurasian watermilfoil the treatment of a portion of Backwater Lake was also completed along with the treatment of Webster Lake. The treatment was completed by application of Sonar herbicide to approximately 175 acres of Webster Lake and approximately 100 acres of Backwater Lake (above the furthest upstream location that Eurasian watermilfoil had been found in past surveys). Initially, Sonar SRP and PR were applied in two applications (6 ppb and 3 ppb) in early and late May. Due to heavy rain and high flow through the lake FasTest (Sonar residual tests) samples indicated dilution had reduced the Sonar concentration within the lake below the level targeted for Eurasian watermilfoil control. This additional dilution, the FasTest results, and the results of EffecTest (tests for biochemical response of plants to Sonar) resulted in the completion of a “bump” application of Sonar in mid-June. This treatment consisted of 2 ppb application to Webster Lake with Sonar AS and a 6.5 ppb application to Backwater Lake with a combination of Sonar AS and PR. In early August an additional “bump” application of approximately 2 ppb was made to Backwater Lake with Sonar AS. The discharge rate for Webster Lake was at an all time high during May and much of June 2002. Eurasian watermilfoil was not observed in late 2002 during informal plant surveys and collected at only one site in Webster Lake and three sites in Backwater Lake during 2003 sampling completed by Aquatic Control biologists (Shuler, 2004). Eurasian watermilfoil was present at 12% of sample sites on Webster Lake in the 2004 Tier II survey. Aquatic Control Inc. and the Webster Lake Conservation Association considered the 2002 whole lake fluridone treatment to be very successful.

In 2003 contact treatments were completed for control of nuisance species in and around dock areas. A total of 28 acres were treated with contact herbicides. A similar treatment was completed on June 15, 2004 to 35.75 acres in Webster Lake and 7.5 acres in Backwater Lake (Figure 28 & 29 and Table 9).

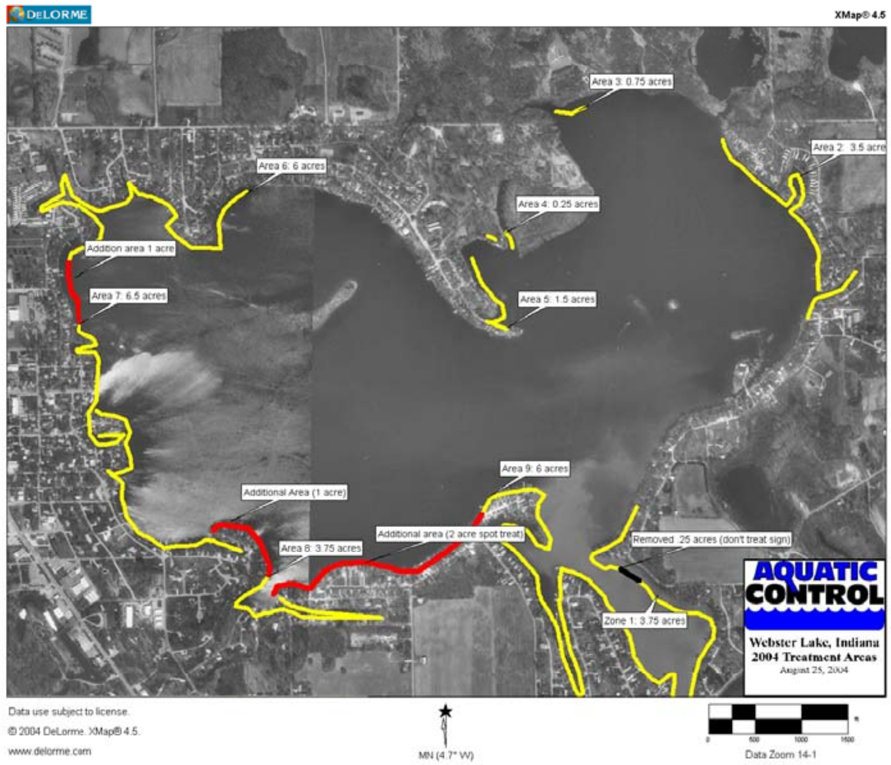

Figure 28. Webster Lake treatment areas, June, 15, 2004 (not to scale see appendix).

Figure 29. Backwater Lake treatment areas, June 8, 2004 (not to scale see appendix).

Aquatic Plant Management Alternatives

Three exotic species are present in Webster Lake; curlyleaf pondweed, purple loosestrife, and Eurasian watermilfoil (purple loosestrife was not document in the 2004 sampling, but has been documented in the past). Eurasian watermilfoil has been the focus of the majority of management activity due to its history of creating nuisance conditions in Webster Lake. It is believed that Eurasian watermilfoil was first introduced from Eurasia or North Africa to an area near Maryland around 1942, possibly through the aquarium trade. Some reports suggest that this species may have been introduced into North America as early as the late 1800's through shipping ballast (Ditomaso & Healy, 2003). This species has now spread throughout the majority of North America and is the primary nuisance submersed aquatic species in Indiana. Once established, growth and physiological characteristics of Eurasian watermilfoil enable it to form a surface canopy and develop into immense stands of weedy vegetation, out competing most submersed species and displacing the native plant community (Madsen et al., 1988).

In order to develop a scientifically sound and effective action plan for control of Eurasian watermilfoil and other nuisance species, all aquatic management alternatives need to be considered. The alternatives that will be discussed include: no action; environmental manipulation; chemical, mechanical, or biological control methods; and any combination of these methods. A summary of the management alternatives can be found at the end of this section in Table 11.

A number of different techniques have been successfully used to control Eurasian watermilfoil. These techniques vary in terms of their efficacy, rapidity, and selectivity, as well as the thoroughness and longevity of control they are capable of achieving. Each technique has advantages and disadvantages, depending on the circumstances. Selectivity is a particularly important characteristic of control techniques. Nearly all aquatic plant control techniques are at least somewhat selective, in that they affect some plant species more than others. Even techniques such as harvesting that have little selectivity within the areas to which they are applied can be used selectively, by choosing only certain areas in which to apply them. Selectivity can also occur after the fact, as when a technique controls all plants equally but some grow back more rapidly. One facet of selecting an appropriate aquatic plant control technique is matching the selectivity of the control technique with the goals of aquatic plant management. When controlling Eurasian watermilfoil, for example, it is typically desirable to use techniques that control Eurasian watermilfoil with minimal impact on most native species (Smith, 2002).

No Action

What if no aquatic plant management activity took place on Webster Lake? Prior to the initiation of the whole lake fluridone treatments, Webster Lake experienced severe restrictions on lake use caused by hundreds of acres of topped out Eurasian watermilfoil beds. This would likely take place in 2-3 years if no management activity took place.

Environment manipulation
Environmental manipulation for Webster Lake would include water level draw-down. Successful use of water draw-down for controlling Eurasian watermilfoil typically requires drawing down water levels sufficiently to expose the entire Eurasian watermilfoil population. This technique can be effective if the drawdown exposes the entire Eurasian watermilfoil population to freezing and thawing, however drawdown can result in the expansion of Eurasian watermilfoil into deeper water. Drawdown can also have negative affects on native plant species. The Webster Lake Conservation Association does not have the ability to draw down the lake sufficiently in order to expose all areas where Eurasian watermilfoil grows.

Mechanical
Mechanical control includes cutting, dredging, or tilling the bottom sediments to eliminate aquatic plant growth. The main advantage to mechanical control is the immediate removal of the plant growth from control areas and the removal of organic matter and nutrients.

One of the most common mechanical control techniques used on larger lakes in Indiana is mechanical harvesting. Mechanical harvesting uses machines which cut plant stems and, in most cases, pick up the cut fragments for disposal. This type of mechanical control has little selectivity. Where a mix of Eurasian watermilfoil and native species exists, harvesting favors the plant species that grow back most rapidly following harvesting. In most cases, Eurasian watermilfoil recovers from harvesting much more rapidly than native plants. Thus, repeated harvesting hastens the replacement of native species by Eurasian watermilfoil and often leads to dense monocultures of Eurasian watermilfoil in frequently harvested areas. Harvesting also stirs up bottom sediments thus reducing water clarity, kills fish and many invertebrates, and hastens the spread of Eurasian watermilfoil via fragmentation.

A specialized harvester has been used by the Webster Lake Conservation Association to manage duckweed in the Webster Bay. This process is time consuming, but it has been used effectively to improve conditions in this area. Harvesting may be one of the best means for removing this nuisance species when it reaches nuisance levels.
Residents of Webster Lake have used a smaller scale harvesting technique by physically removing plants from dock or swimming areas. Residents should keep in mind that only a 625 square foot area can be harvested without obtaining a permit from IDNR.

Biological
Biological controls reduce aquatic vegetation using other organisms that consume aquatic plants or cause them to become diseased (Smith, 2002). The main biological controls for Eurasian watermilfoil used in Indiana are the white amur (grass carp) and the milfoil weevil.

The white amur or grass carp *Ctenopharyngodon idella* is a herbivorous fish imported from Asia. Triploid grass carp, the sterile genetic derivative of the diploid grass carp, are legal for use in Indiana. Grass carp tend to produce all or nothing aquatic plant control.

It is very difficult to achieve a stocking rate sufficient to selectively control nuisance species without eliminating all submersed vegetation. They are not particularly appropriate for Eurasian watermilfoil control because Eurasian watermilfoil is low on their feeding preference list; thus, they eat most native plants before consuming Eurasian watermilfoil (Smith, 2002). Grass carp are also difficult to remove from a lake once they have been stocked. Grass carp are not recommended for Eurasian watermilfoil control.

The milfoil weevil, *Euhrychiopsis lecontei,* is a native North American insect that consumes Eurasian and Northern watermilfoil. The weevil was discovered following a natural decline of Eurasian watermilfoil in Brownington Pond, Vermont (Creed and Sheldon, 1993), and has apparently caused declines in several other water bodies. Weevil larvae burrow in the stem of Eurasian watermilfoil and consume the vascular tissue thus interrupting the flow of sugars and other materials between the upper and lower parts of the plant. Holes where the larvae burrow into and out of the stem allow disease organisms a foothold in the plants and allow gases to escape from the stem, causing the plants to lose buoyancy and sink (Creed et al. 1992).

Concerns about the use of the weevil as a biological control agent relate to whether introductions of the milfoil weevil will reliably produce reductions in Eurasian watermilfoil and whether the resulting reductions will be sufficient to satisfy users of the lake (Smith, 2002). Following our research, no conclusive data concerning the role of weevils in reducing Eurasian watermilfoil populations has been made available. In 2003, Scribailo & Alix conducted a weevil release study on three Indiana lakes and had no conclusive evidence supporting the use of weevils in reducing milfoil populations. Weevils may reduce milfoil populations in some lakes, but predicting which lakes and how much, if any, control will be achieved has not been documented.

Chemical Control

Chemical control uses chemical herbicides to reduce or eliminate aquatic plant growth. The main advantage of using herbicides is their overall effectiveness. The public's main concern over herbicide use is safety. This should not be a concern due to the extensive testing which is required prior to herbicide being approved for use in the aquatic environment. These tests ensure that the herbicides are low in toxicity to human and animal life and they are not overly persistent or bioaccumulated in fish or other organisms.

There are two different types of aquatic herbicides; systemic and contact. Systemic herbicides are translocated throughout the plants and thereby kill the entire plant. Fluridone (trade name Sonar & Avast!), 2,4-D (trade name Navigate, Aqua-Kleen, & DMA4 IVM), and trichlopyr (trade name Renovate) are systemic herbicides that can effectively control Eurasian watermilfoil. Fluridone also effectively controls curlyleaf pondweed.

Based upon the author's experience and personal communication with a vast array of North American aquatic plant managers, whole-lake fluridone applications are by far the most effective means of controlling Eurasian watermilfoil. Successful fluridone treatments yield a dramatic reduction in the abundance of Eurasian watermilfoil, often reducing it to the point that Eurasian watermilfoil plants are difficult to detect following treatment (Smith, 2002). An advantage to using fluridone over most contact herbicides is its selectivity. Most strains of Eurasian watermilfoil have a lower tolerance to fluridone than the majority of native species, so if the proper rates are applied Eurasian water milfoil can be controlled with little harm to the majority of native species.

Triclopyr is a systemic herbicide that has recently been approved for use in aquatics. Triclopyr typically is used for treating isolated milfoil beds as opposed to whole lake treatments. This herbicide is very selective to Eurasian watermilfoil. Getsinger et. al. (1997) studied the effects of Triclopyr in a paper titled "Restoring Native Vegetation in a Eurasian Watermilfoil Dominated Plant Community Using the Herbicide Triclopyr." They found Eurasian watermilfoil biomass was reduced by 99% in treated areas at 4 weeks post-treatment, remained low one year later, and was still at acceptable levels of control at two years post-treatment. Non-target native plant biomass increased 500-1000% by one year post-treatment, and remained significantly higher in the cove plot at two years post-treatment. Native species diversity doubled following herbicide treatment, and the restoration of the community delayed the re-establishment and dominance of Eurasian watermilfoil for three growing season. Triclopyr is a good alternative to fluridone when Eurasian watermilfoil is not abundant throughout an entire water body. It is our recommendation that this new management technique be used on Webster Lake in 2005 in order to delay the need for another whole lake fluridone treatment.

Applied properly, 2,4-D can also yield major reductions in the abundance of Eurasian watermilfoil, but long-term reductions are more difficult to achieve using 2,4-D than using whole-lake fluridone applications. Treatments must be even and dose rates accurate. Under the best circumstances, some areas will probably need to be treated repeatedly before the Eurasian watermilfoil in them is controlled. Also, the difficulty of finding and treating areas of sparse Eurasian watermilfoil makes it likely that Eurasian watermilfoil will be reestablished from plants surviving in these areas (Smith 2002). This formulation should be used much like Triclopyr, but the same results may not occur. Unlike Triclopyr, 2,4-D can impact the native species coontail. This herbicide is not approved for use in Webster Lake due to drinking water restrictions.

Contact herbicides can also be effective for controlling submersed vegetation in the short term. The three primary contact herbicides used for control of submersed vegetation are diquat (trade name Reward), endothal (trade name Aquathol), and copper based formulations (trade names Komeen, Nautique, and Clearigate).

Historically, a drawback to the use of contact herbicides has been the lack of selectivity exhibited by these herbicides. However, a study recently completed by Skogerboe and Getsinger in 2002 outlines how endothal can be used for control of the exotic species curlyleaf pondweed and Eurasian watermilfoil with little effect on the majority of native species. They found early season treatments with endothall effectively controlled

Eurasian watermilfoil and curlyleaf pondweed at several application rates with no regrowth eight weeks after treatment. Sago pondweed, eel grass, and Illinois pondweed biomass were also significantly reduced following the endothall application, but regrowth was observed at eight weeks post-treatment. Coontail and elodea showed no effects from endothall at three of the lower application rates. Spatterdock, pickerelweed, cattail, and smartweed were not injured at any of the application rates (Skogerboe & Getsinger 2002). This type of treatment strategy could be applied to lakes that have large areas of both curlyleaf pondweed and Eurasian watermilfoil. Endothal could also be effective the year after whole lake fluridone treatments where curlyleaf pondweed typically returns the following season. Endothal has been used for many years in Webster Lake for control of Eurasian watermilfoil and mixed pondweeds. Results have been mixed, but this may be due to the limited areas which were treated resulting in reinfestation from untreated areas of the lake. This herbicide should still be considered as an effective tool for control of areas with nuisance pondweed growth mixed with Eurasian watermilfoil.

Diquat and many of the copper formulations are effective, fast acting contact herbicides. These formulations are typically used when control of all submersed vegetation is desired. These herbicides are commonly used for control of nuisance vegetation around docks and near-shore high-use areas. These herbicides are not selective and plants can often times recover in 4-8 weeks after treatment. Diquat has been used on Webster Lake in early summer to control nuisance vegetation in and around dock and swimming areas.

Table 11. Summary of Potential Vegetation Control Methods for Webster Lake.

Control Method	Advantages	Disadvantages	Conclusion
No Action	No direct cost, potentially less controversy	No plant control, loss of property value, degradation of fish habitat, difficult boating, and dangerous swimming.	Not an option due to past Eurasian watermilfoil infestation.
Environmental Manipulation (drawdown)	Low cost, compaction of flocculent sediments, residents can access and improve docks and seawalls, may get control of some nuisance species	Unpredictable plant control, exposes desirable plants and animals to freezing and thawing, dependent on good freeze, could impede recreation, dependent on spring rains to raise water level, and could lead to dissolved oxygen problems.	Could damage desirable native beds of emergent and submersed vegetation. May not be feasible due to control structure.
Mechanical (cutting, dredging, or tilling)	less controversy, one can target areas of desired control, and removes organics.	Possibility of spreading exotic vegetation, labor intensive, and harvesting can promote increased milfoil growth.	Not good option for nuisance submersed, but should continue on duckweed.
Biological Control (milfoil weevil)	No chemical needed, naturally occurring native species, no use restrictions following application, selective for Eurasian watermilfoil, and known to cause fatal damage to plant	Studies have been inconclusive on the effectiveness and cost is relatively high compared to most other control methods.	No proof that this method is effective. Too large of an investment for unproven method.
Biological Control (Grass Carp)	No chemical needed, no use restrictions following application, and proven to consume aquatic vegetation.	Prefers many of the native species over exotic species, non-native fish species, once they are introduced selective removal is impossible.	Not a good option due to preference of native vegetation and inability to remove once stocked.
Chemical Control	Proven technique, can be selective for exotic species, relatively easy application, and fast results.	Higher cost than most techniques, public concern over chemicals, build-up of dead plant material following application, and lake use restrictions	Best option, proven to be effective, selective for exotic species & use restrictions minimal.

Action Plan

The primary nuisance species within Webster and Backwater Lakes are the exotic plants Eurasian watermilfoil and curlyleaf pondweed. Native aquatic plants that have historically developed nuisance conditions when left to grow unmanaged include coontail, duckweed, and Chara algae. Due to the morphology of the lakes, the extensive shallow areas, and abundant nutrients, a large percentage of the lakes become infested with heavy growths of both exotic and native aquatic macrophytes. Submersed aquatic macrophytes inhibit the recreational uses of the lakes, including: boating, swimming, water skiing, fishing, and may degrade the fish habitat when uncontrolled growth occurs. The historical level of plants within Webster and Backwater Lakes has exceeded desirable levels for recreational use and for fish habitat. Degradation of fish habitat was noted in the summary of fish surveys given by J.F. New & Associates in their "summary of fish management reports" (J.F. New & Associates 2000).

The primary recommendation for plant control within Webster and Backwater Lakes has been the periodic use of a fluridone based aquatic herbicide for the systemic control of the exotic macrophytes Eurasian watermilfoil and curlyleaf pondweed. The technique has proven to provide the most cost effective and selective control for Eurasian watermilfoil throughout the United States. However, in the past, no selective herbicide treatments for the control of these exotic species have been completed in non-fluridone treatment years. This has been due to a lack of funding for these types of treatments. An increase in the selective treatment in non-fluridone years may reduce the frequency of whole lake fluridone treatments. I.D.N.R. has expressed concern over perceived reduction in coontail abundance and the overall littoral zone plant coverage immediately following fluridone treatments. Due to the presence of an excellent muskie fishery, I.D.N.R. has special concern for Webster Lake. It is believed that muskie prefer dense macrophyte coverage. Based on these concerns and a desire to utilize new and innovative aquatic vegetation control techniques, it is recommended that a stepped up program of selective control of Eurasian watermilfoil and curlyleaf pondweed treatments be completed in non-fluridone treatment seasons. These treatments should include the use of Aquathol K for early season curlyleaf pondweed control and the recently approved Renovate herbicide for Eurasian watermilfoil control. A trial early season curlyleaf pondweed treatment should be conducted in April of 2005. A maximum of 20 acres of the densest curlyleaf pondweed beds should be selected for treatment following April plant sampling (this species is present throughout the winter and begins rapid growth in early spring). Eurasian watermilfoil treatment areas can be determined following late spring sampling (late May/early June). The goal of these treatments is to reduce the frequency of occurrence of exotic species and increase the frequency of occurrence of native species. An overall goal of 75% frequency of occurrence of vegetation in littoral areas should be in place for Webster Lake (in 2004, aquatic vegetation occurred at 79% of littoral sites). A fluridone treatment should only be initiated if it becomes necessary to treat more than 100 acres of Eurasian watermilfoil. All areas which have Eurasian watermilfoil will be treated. It is difficult to predict when and if these species will reach this density and abundance, so the lake should be closely monitored. Three Tier II surveys should be completed in 2005 in order to monitor the plant community. The surveys should be completed in early spring prior to curlyleaf pondweed teatment, late spring to document curlyleaf treatment effectiveness and Eurasian watermilfoil abundance, and late summer to document native plant recovery and Eurasian watermilfoil and curlyleaf pondweed density and abundance. The need for a future fluridone treatment should be determined following a late summer plant survey.

Each season a selected area treatment of nuisance species in near-shore, developed areas, using contact aquatic herbicides should be completed. These treatments will reduce nuisance conditions in critical areas such as docks, swimming areas, navigation lanes, and marinas. Traditionally 65 acres has required treatment on Webster Lake and 5 acres on Backwater Lake (see Figure 28 & 29 in Treatment History). Currently available contact herbicides include: Aquathol K, Reward, Komeen, and Nautique. Choice of herbicide for a given season will be dependent upon many factors including; macrophyte species, growth stage of plant, weather conditions, lake water quality and water level conditions at time of treatment. In addition to macrophyte control, selected near-shore areas need to be treated with algaecides to effectively control nuisance beds of Chara algae. These algae treatments would also control nuisance filamentous algae within the treatment areas.

Table 12 includes an estimate of the budget needed to complete selective treatments of Eurasian watermilfoil and curlyleaf pondweed, near-shore contact treatments, and vegetation sampling and plan updates. It is difficult to estimate how much vegetation will require treatment due to the variety of factors that affect aquatic vegetation growth. This budget does not include a whole lake fluridone treatment, but this option may be needed if exotic species cannot be controlled using the new techniques. It is roughly estimated that up to 40 acres of Eurasian watermilfoil and curlyleaf pondweed may need treatment next season. Hopefully, this treatment will be successful and reduce the need for treatment in following years, but due to the shallow productive nature of Webster Lake, it is recommended that the association budgets for the same amount of treatment in following years. This treatment along with the vegetation sampling and plan update should be eligible for funding from the LARE Program. Adjustments to this budget will likely be needed and can be made after data is collected from plant surveys. This budget does not include near-shore contact treatments to Backwater Lake, but does include Eurasian watermilfoil treatments.

Table 12. Budget estimates for action plan

	2005	2006	2007	2008
Herbicide & Application Cost (Eurasian watermilfoil and curlyleaf pondweed 20-40 acres)	$16,000	$16,000	$16,000	$16,000
Herbicide & Application Cost (near-shore nuisance native species 50-65 acres)	$25,000	$25,000	$25,000	$25,000
Vegetation Sampling & Plan Update (three Tier II surveys)	$6,000	$6,000	$6,000	$6,000
Total:	**$47,000**	**$47,000**	**$47,000**	**$47,000**

Eurasian watermilfoil in Kiser lake should be either physically removed by divers uprooting the entire plant, including the root crown, or by spot treatment with granular 2,4-D for systemic eradication of this plant before it spreads throughout the lake.

Purple loosestrife is an exotic invasive wetland plant that is present and expanding in the Webster lake watershed. This plant is capable of crowding out many desirable wetland plants, including cattails. Purple loosestrife has minimal value to wildlife. No recorded control efforts have been directed to this species in the past. With the approval of Renovate herbicide there is now a viable tool for use in controlling the spread of this species with minimal damage to desirable wetland plants. It is recommended that a pilot project for control of purple loosestrife be initiated in the near future to evaluate the potential for integrating a control program into the long-range aquatic vegetation management plan for Webster Lake.

Duckweed is a common wetland species in Indiana. Dense growths of this floating plant occur in Backwater Lake and Webster Bay. The poor circulation of water within Webster Bay results in excessive coverage of duckweed off the main channel in mid-late summer. High flows move large quantities of duckweed from Backwater into Webster Bay and out into the main portion of Webster Lake. Prevailing winds concentrate the duckweed growth in various near shore locations throughout the lake resulting in undesirable situations for many homeowners. Present control efforts are limited to the periodic use of a custom built duckweed harvester mounted on a pontoon boat. This unit has been reasonably successful in giving relief from heavy accumulations of duckweed, particularly in Webster Bay. Operation of the unit is labor intensive and inefficient; however, volunteers living in Webster Bay have made a significant impact on the duckweed problem in the past several years. Duckweed can be controlled with Sonar aquatic herbicide at low doses without damage to desirable macrophytes. However, whole lake treatment for this species is probably not economically justifiable at this time. Experience has shown relatively good control of this nuisance plant with multiple applications of very low doses of Sonar in selected areas. Seasonal control can be expected from Sonar treatments.

Duckweed can also be controlled with Reward aquatic herbicide and suitable aquatic surfactants with surface spraying of nuisance areas. Reward is a contact herbicide and does not give any residual control of duckweed. It is recommended that a pilot project be initiated using all available tools including; partial sequential treatments of Webster Bay with low doses of Sonar aquatic herbicide intermittently during the summer season, selected area spraying of duckweed with Reward, and continued use of the harvester to evaluate the best management practice for inclusion in the vegetation management plan in the future. A management program built on the pilot project results could eliminate a majority of the duckweed problem throughout Webster Lake.

Planting of native aquatic plants should be considered as a technique to help restore the plant community in some areas of the lakes. A detailed planting program is beyond the scope of this study, however, we recommend the introduction and/or re-establishment of some or all of the following desirable wetland plants in near-shore developed areas and within and adjacent to remaining wetlands: white water lily, spatterdock, arrowhead, pickerelweed, bulrush, cardinal flower, water smartweed, swamp milkweed, square-stemmed spikerush, water iris, rose mallow, buttonbush, elderberry and dogwood. These species are typically considered attractive, beneficial fish and wildlife habitat, relatively easy to establish, and their spread can be managed if nuisance conditions develop. A good reference for wetland plantings is “Wetland Planting Guide for the Northeastern United States Plants for Wetland Creation, Restoration, and Enhancement”, published by Environmental Concern, Inc. (Library of Congress Catalog Card Number 93-71108).

Current state law allows riparian owners to control up to 625 square feet of vegetation around dock and beach areas without a permit. This should allow for the maintenance of most plantings once established. The Webster Lake Conservation Association should consider providing education materials about these plantings to the membership and could also consider an annual budget for planting projects of this nature sponsored by the Association.

The control of exotic species will help reduce nuisance conditions within the lake. This management plan will also reduce the competition from exotics and nuisance natives, which are limiting the growth of more desirable native species. The overall goal of the plan is to provide a diverse aquatic plant community at desirable levels for recreational uses and for the fish community.

Education

Educational efforts should be made by the Webster Lake Conservation Association on an annual basis to inform lake users about the aquatic vegetation management program. Information should be distributed through meetings, newsletters, and brochures about the plant species within the lake, problems some of the species can cause, management methods completed in the past and those being considered for the future. Those directly involved with the aquatic plant management program are encouraged to read the book; *Aquatic Plant Management in Lakes and Reservoirs*, this book is a joint publication of the Aquatic Plant Management Society (APMS) and The North American Lake Management Society (NALMS). It is a source of information about most aspects of aquatic plant management and provides helpful insight for developing plans that meet needs of all user groups typically involved.

A public meeting was held on November 18, 2004. Notices of this meeting were published in the local paper and in a newsletter distributed to Webster Lake Conservation Association members. Twenty-two lake users were present at the meeting and discussed the plant sampling and the 2005 action plan. Lake users overwhelmingly expressed their satisfaction with the current management practices, but were willing to attempt the new management strategy in an effort to reduce the frequency of fluridone treatments. Nearly all in attendance agreed that their overall enjoyment of the lake has increased since the initiation of the periodic whole lake fluridone treatments.

References

Applied Biochemists, 1998. Water weeds and algae, 5th edition. Applied Biochemists, J. C. Schmidt and J. R. Kannenberg, editors. Milwaukee, Wisconsin.

Bachmann, R.W., Horsburgh, C.A.., Hoyer, M.V., Mataraza, L.K., andCanfield, D.E.. 2002. Relations between trophic state indicators and plant biomass in Florida Lakes. Department of Fisheries and Aquatic Sciences, University of Florida. Hydrobiologia 470:219-234.

Blatchley, W.S. 1900. Indiana Department of Geology and Natural Resources – Twenty-Fifth Annual Report. Wm. B. Burford Printing, Indianapolis, IN.

Chadde, Steve W. 1998. A Great Lakes Wetland Flora. Pockteflora Press, Calumet Michigan.

Curtis, L. 1998. Aquatic Plants of Northeastern Illinois. U.S. Library of Congress.

DiTomaso, J. M. and Healy, E.A. 2003. Aquatic and Riparian Weeds of the West. University of California Agriculture and Natural Resources. Oakland, CA.

Fassett, Norman C. 1968. A Manual of Aquatic Plants. The University of Wisconsin Press. Madison, WI.

Getsinger, K.D., Turner, E.G., Madsen, J.D., and Netherland, M.D. 1997. Restoring Native Vegetation in a Eurasian Water Milfoil-Dominated Plant Community Using The Herbicide Triclopyr. Regulated Rivers: Research & Management, Vol. 13, 357-375.

Homoya, M.A., B.D. Abrell, J.R. Aldrich, and Post, T.W. 1985. The Natural Regions of Indiana. Indiana Academy of Science. Vol. 94 Indiana Natural Heritage Program. Indiana Department of Natural Resources, Indianapolis, IN.

IDNR 2004. Procedure Manual For Surveying Aquatic Vegetation: Tier I Reconnaissance Surveys. IN Department of Natural Resources, Division of Soil Conservation.

IDNR 2004. Procedure Manual For Surveying Aquatic Vegetation: Tier II Reconnaissance Surveys. IN Department of Natural Resources, Division of Soil Conservation.

J.F. New and Associates, Inc. 2000. Webster Lake/Backwaters Area Diagnostic Study. Loose-leaf publication, 83 pp.

Maceina, M.J., Reeves, W.C., Wrenn, W.B., & Lowery, D.R. Relationships between Largemouth Bass and Aquatic Plants in Guntersville Reservoir, Alabama. American Fisheries Society Symposium 16:382-395. 1996.

Madsen, J.D., Sutherland, J.W., Bloomfield, J.A., Eichler, L.W., and Boylen, C.W. 1988. The decline of native vegetation under dense Eurasian watermilfoil canopies. Journal of Aquatic Plant Management., 29, 94-99.

Michigan Department of Environmental Quality 2001. Land and Water Management Division, Inland Lakes and Wetlands Unit. Procedures for Aquatic Vegetation Surveys.

North American Lake Management Society and the Aquatic Plant Management Society. 1997. Aquatic Plant Management in Lakes and Reservoirs. U.S. Environmental Protection Agency, Office of Water Assessment and Watershed Protection Division, Washington, DC.

Pearson, J. 1985. Webster Lake, Kosciusko County, Fish Management Report. Indiana Department of Natural Resources, Indianapolis, IN.

Pearson, J. 1989. Webster Lake, Kosciusko County, Fish Population Survey. Indiana Department of Natural Resources, Indianapolis, IN.

Pearson, J. 1995. Webster Lake, Kosciusko County, Fish Management Report. Indiana Department of Natural Resources, Indianapolis, IN.

Pearson, J. 1999. Muskellunge Population Characteristics at Webster Lake, Indiana. Indiana Department of Natural Resources, Indianapolis, IN.

Pearson, J. 2004. A proposed sampling method to assess occurrence, abundance and distribution of submersed aquatic plants in Indiana lakes. IN Department of Natural Resources. Division of Fish & Wildlife.

Sabol B.M. and Melton R.E. 1995. Development of an automated system for detection and mapping of submersed aquatic vegetation with hydroacoustic and global positioning system technologies, report I: the Submersed Aquatic Vegetation Early Warning System (SAVEWS) – system description and user's guide (Version 1.0), USACE Waterways Experiment Station, Vicksburg, MS.

Sabol B.M. and Burczynski, J. 1998. Digital echo sounder system for characterizing vegetation in shallow-water environments. Proceedings of the Fourth European Conference on Underwater Acoustics. Eds. A. Alipii and G.B. Canelli. Rome. pp 165-171.

Scribalio, R.W. and M.S. Alix 2003. Final Report on the Weevil Release

Study for Indiana Lakes. Department of Botany and Plant Pathology. Purdue University. West Lafayette, IN.

Skogerboe, J.G., & Getsinger, K.D. 2002. Endothall species selectivity evaluation: northern latitude aquatic plant community. J. Aquatic Plant Management. 40: 1-5.

Schneider, J.C. 2000. Evaluation of the effects of the herbicide sonar on sport fish populations in Michigan Lakes. Michigan Department of Natural Resources Fisheries Technical Report No. 2000-2. Michigan Department of Natural Resources Institute for Fisheries Research. Ann Arbor, MI.

Scribailo, R. 2001 Associate Professor of Biological Sciences, Purdue University North Central. Personal Communication.

Shipman, S.T. 1977. Webster Lake, Kosciusko County, Fish Management Report 1976. Indiana Department of Natural Resources, Indianapolis, IN.

Shuler, S. 2003. Webster Lake 2003 Aquatic Vegetation Survey Report. Aquatic Control Inc., Seymour, IN.

Shuler S., Long N.W., Hastie B.F. 2004. Webster Lake Mapping Study and Aquatic Vegetation Management Plan. Aquatic Control Inc. Seymour, IN.

Smith, C. S. 2002 Houghton Lake Management Feasibility Study. Prepared for the Houghton Lake Improvement Board. Remetrix LLC. Indianapolis, IN.

White, G.M. 1998a. Exotic Plant Species in Indiana Lakes. Report prepared for the Nonindigenous Aquatic Species Database, USGS, Gainesville, Florida. Indiana Department of Natural Resources, Division of Soil Conservation.

White, G.M. 1998b. Factors Affecting Estimated Cost of Aquatic Plant Control in Indiana Lakes. Indiana Department of Natural Resources, Division of Soil Conservation.

Winterringer, G. S. and Lopinot, A. C. 1977. Aquatic Plants of Illinois. Department of Registration & Education, Illinois State Museum Division & Department of Conservation, Division of Fisheries. Springfield, IL.

Appendix A. Macrophyte List for the Webster, Backwater, & Kiser Lake Chain

Common Name	Scientific Name	1976[1]	1985[1]	1988[1]	1995[1]	1999[2]	2001[3]	2002[15]	2003[17]	2004[18]	Status[4]
Coontail	*Ceratophyllum demersum*		X	X	X	X	X	X	X	X	
Chara (Muskgrass)	*Chara spp.*		X	X	X	X	X	X	X	X	
Chara (Muskgrass)[5]	*Chara globularis*						X				
Dogwood	*Cornus spp.*					X					
Common waterweed	*Elodea canadensis*		X			X	X	X		X	
Rose mallow	*Hibiscus spp.*[7]					X	X				
Duckweed	*Lemna spp.*	X	X	X	X	X	X	X		X	
Small duckweed	*Lemna minor*						X	X			
Purple loosestrife	*Lythrum salicaria*		X	X	X	X	X				Exotic
Milfoil[5]	*Myriophyllum spp.*	X	X	X	X	X	X	X[16]	X		
Eurasian water-milfoil[5]	*Myriophylum spicatum*					X	X	X	X	X	Exotic
Whorled water milfoil[5]	*Myriophyllum verticillatum*[8]					X	X				ST
Slender (Common) naiad	*Najas flexilis*					X	X	X	X	X	
Southern naiad	*Najas guadalupensis*						X				
Spiny naiad[6]	*Najas marina*						X		X	X	Exotic
Brittle naiad	*Najas minor*					X	X				
Nitella sp.	*Nitella sp.*									X	
Yellow pond lily	*Nuphar advena*	X	X	X	X	X	X	X	X	X	
Water lily	*Nymphaea spp.*	X	X	X	X	X	X	X			
White water lily	*Nymphaea odorata*						X	X	X	X	
Pickerelweed	*Pantederia cordata*						X				
Arrow arum	*Peltandra virginica*		X	X	X	X	X				
Large-leaved pondweed	*Potamogetan amplifolius*		X	X	X	X	X	X			
Curlyleaf pondweed	*Potamogetan crispus*	X	X	X	X	X	X	X	X	X	Exotic
Narrow-leaved pondweed[5]	*Potamogetan foliosus*[9]		X	X	X		X		X		
Variable pondweed[5]	*Potamogetan gramineus*[10]					X	X				
Illinois pondweed[5]	*Potamogetan illinoensis*					X				X	
Long-leaf pondweed[5]	*Potamogetan nodosus*		X	X	X		X				
Small pondweed[5]	*Potamogetan pusillus*						X	X		X	SR
Richardson's pondweed	*Potamogetan richardsonii*									X	
Flatstem pondweed	*Potamogetan zosteriformis*					X	X		X	X	
Arrowhead	*Sagittaria spp.*	X				X					
Arrowhead[5,6]	*Sagittaria ambigua*[11]						X				SE
Willow	*Salix spp.*					X	X				
Softstem bullrush	*Scirpus spp.*	X				X	X				
Burreed	*Sparganium spp.*					X	X				
Giant duckweed	*Spirodella polyrhiza*[12]					X	X				
Sago pondweed[5]	*Stuckenia pectinata*[13]						X		X	X	
Cattail	*Typha spp.*	X	X	X	X	X	X				
Narrow-leaved cattail	*Typha angustifolia*						X				
Broad-leaved cattail	*Typha latifolia*						X				
Bladderwort[5]	*Utricularia spp.*[14]						X				
Great bladder wart[5]	*Utricularia vulgaris*						X				
Watermeal	*Wolfia spp.*		X			X	X			X	
Horned Pondweed	*Zannichellia palustris*							X		X	SE
Water star-grass[5]	*Zosterella dubia*						X		X	X	

Footnotes:
1 IDNR plant surveys conducted during July fish surveys
2 Data collected by J.F. New Ecological Services Department in 1999
3 Data collected by Aquatic Control, Inc. and ReMetrix in August, 2001 for Webster, Backwater, Kiser, Goldeneye Pond, Ruddy Pond, Grindle Lake North, & Grindle Lake South
4 IDNR Division of Nature Preserves
5 2001 samples identified by Dr. Robin Scribailo, Associate Professor of Biological Sciences at Purdue University North Central
6 Species only found in Kiser Lake
7 Probably *H. palustris*
8 Sample given to Dr. Scribailo was not complete enough to make a positive identification. Could also be *M. sibiricum* (formerly called *M. exalbescens*). *M. verticillatum* is a state endangered species.
9 Sample given to Dr. Scribailo was not complete enough to make a positive identification. Sample sent could also be *P. pusillus*.

Footnotes: Continued

10 Sample given to Dr. Scribailo was not complete enough to make a positive identification. Sample sent could be *P. illinoensis*.
11 Second population of this plant found in the state of Indiana.
12 Reported by J.F. New as *S. elirasia* but we could not find any information on this species. *S. elirasia* is most probably *S. polyrhiza*.
13 *Stuckenia pectinata* was formerly known as *Potamogetan pectinatus*.
14 Sample given to Dr. Scribailo was not complete enough to make a positive identification. Sample sent may be *U. gibba*.
15 Data Collected by Aquatic Control, Inc in April, 2002
16 Identified by Aquatic Control as *Myriophyllum sibiricum*
17 Data collected by Aquatic Control, September 8, 2003
18 Data collected by Aquatic Control, August 25, 2004.

<u>Coontail</u> (*Ceratophylum demersum*) is a commonly occurring aquatic plant in the Midwest in neutral to alkaline waters[1]. It is a submersed dicot with coarsely toothed leaves whorled about the stem[2]. This plant is given its name due to its resemblance to the tail of a raccoon. Coontail has been found to be an important food source for wildfowl as well as a good shelter for small animals[2]. This plant is also a good shelter for young fish, and support of insects[2], but has been known to crowd out other species of aquatic plants[3].

<u>Common waterweed</u> (*Elodea canadensis*) is a bright green submersed monocot with three leaves whorled about the stem[2]. The leaves curve back and are rounded at the tips[1]. Elodea is a wildlife food of varying importance[2]. It can shelter smaller aquatic life, is sparingly eaten by muskrats, and may suppress other plants[2]. Elodea can be important to the fishery of a lake due to its ability to shelter and support insects that can be used in fish production[2].

<u>Eel grass</u> (*Vallisnaria spiralis*) is also referred to as tape grass. This submersed plant is dioecious and has linear submerged or floating leaves that are strap-or tape-shaped. This plant has not been documented from any plant surveys but has been seen by the Author floating in Webster Lake. This plant was also listed on several permit applications in the mid-1980's.

<u>Eurasian watermilfoil</u> (*Myriophyllum spicatum*) is an exotic aquatic plant that has been known to crowd out native species of plants. This species spreads quickly because it can grow from very small plant fragments and survive in low light and nutrient conditions[3]. This dicot has stems that typically grow to the water surface and branch out forming a canopy that shades other species of aquatic plants. Eurasian water-milfoil has characteristic red to pink flowering spikes that protrude from the water surface one to two inches high[1]. The segmented leaves grow in whorls of three to four around the stem[1]. This exotic plant is easily differentiated from its native relative, northern milfoil, by stem growth and the numbers of sections per leaf.

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[1] Chadde, S. 1998. Great lakes wetland flora. Pocketflora Press, Calumet, Michigan.
[2] Fassett, N. 1957. A manual of aquatic plants, 2nd edition. The University of Wisconsin Press, Madison, Wisconsin.
[3] Applied Biocehmists, 1998. Water weeds and algae, 5th edition. Applied Biochemists, J. C. Schmidt and J. R. Kannenberg, editors. Milwaukee, Wisconsin.

Spiny naiad (*Najas marina*) is a submersed monocot with deeply toothed leaf margins that grow opposite or in whorles[1]. This plant is a food source for ducks[2]. Naiads are generally good food producers and shelter providers for a variety of fish[2]. This plant was only found in Kiser Lake[4].

Yellow pond lily (*Nuphar advena*) is an emergent dicot with broad, deeply lobed leaves emerging from the water[1]. This plant has distinctive large yellow flowers emanating from spikes. Yellow pond lily produces seeds and rootstocks that are used by wildfowl, beaver, moose and porcupine[2]. This plant attracts wildfowl and marsh birds and the bases of the petioles are eaten by muskrats[2]. Yellow pond lilies are a poor producer of food for fish, but provide good shade and shelter[2].

White water lily (*Nymphaea odorata*) is a floating attached dicot that grows from tubers and produces broad, deeply lobed floating leaves and white flowers[1]. This plant produces seed that is fair food for wildfowl[2]. The root stocks and petiole bases are eaten by muskrats and the "roots" are eaten by beaver, deer, moose, and porcupine[2]. White water lilies can provide good habitat for fish, but can induce a negative value when too dense[2].

Large-leaved pondweed (*Potamogetan amplifolius*) is a submersed to floating attached monocot with folded, ovate, sickle shaped upper leaves and lanced shaped underwater leaves that are usually not folded[1]. Flowers occur on dense cylindrical spikes[1]. This plant supports insects and is a good food supply for fish[2]. Large-leaved pondweed is a desirable duck food[2].

Curlyleaf pondweed (*Potamogetan crispus*) is a submersed monocot with slightly clasping, rounded tip leaves. The flowers occur on dense cylindrical spikes and produces distinctive beaked fruit[1]. Curly leaf is eaten by ducks, but may become a weed[2]. This plant provides good food, shelter, and shade for fish and is important for early spawning fish like carp and goldfish[2].

Narrow-leaved pondweed (*Potamogetan foliosus*) is a submersed monocot with long, narrow leaves and flowers in rounded to short cylindrical spikes[1]. This plant is often important for wildfowl and provides good cover and food for fish[2].

Small pondweed (*Potamogetan pusillus*) is a submersed monocot with slender, long leaves. Its fruit is green to brown and has a flat beak[1]. This plant provides fish with good cover and food and is a good food source for wildfowl[2]. This species has a propensity for developing nuisance conditions when competition from other species is not present.

Sago pondweed (*Stuckenia pectinata*) is a submersed monocot with leaves that are threadlike to narrowly linear that form a sheath around the stem[1]. The nutlet and tubers of this plant make it the most important pondweed for ducks[2]. It also provides food and shelter for young trout and other fish[2]. This species can produce thick nuisance growth in shallow near-shore areas of lakes.

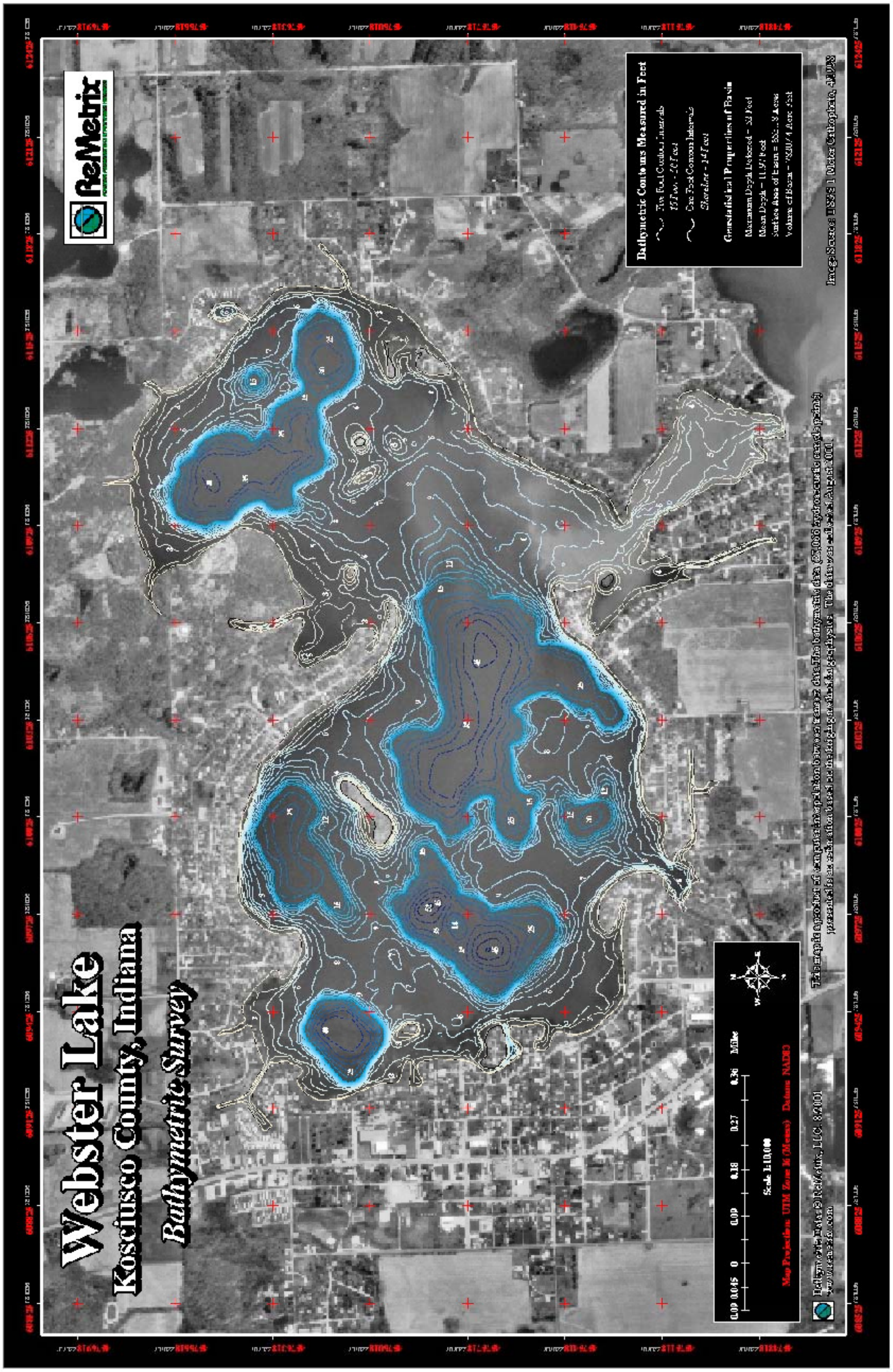
---

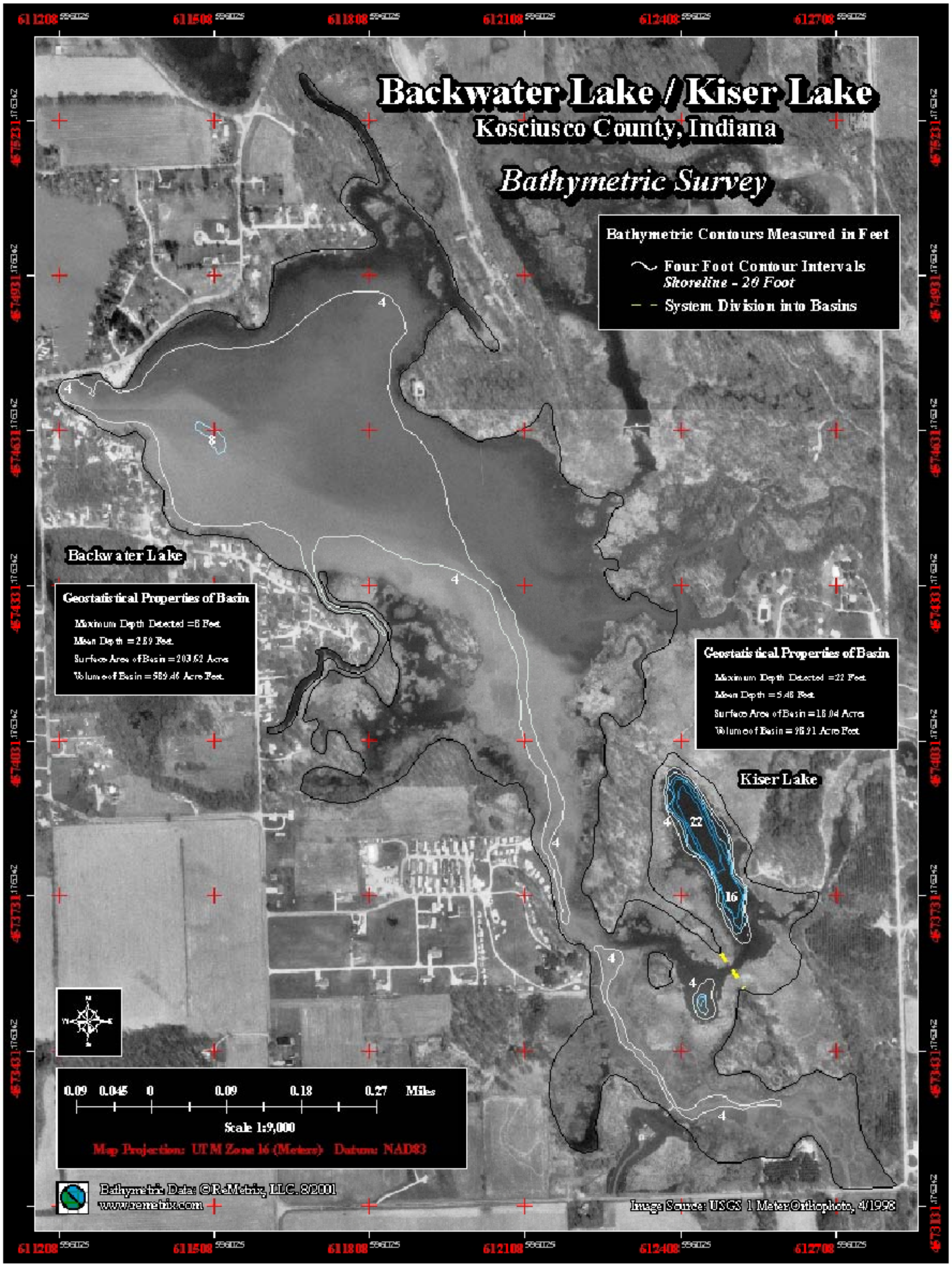
[1] Chadde, S. 1998. Great lakes wetland flora. Pocketflora Press, Calumet, Michigan.

[2] Fassett, N. 1957. A manual of aquatic plants, 2nd edition. The University of Wisconsin Press, Madison, Wisconsin.

[3] Applied Biocehmists, 1998. Water weeds and algae, 5th edition. Applied Biochemists, J. C. Schmidt and J. R. Kannenberg, editors. Milwaukee, Wisconsin.

Appendix B. Maps




Backwater Lake / Kiser Lake
Kosciusco County, Indiana
Bathymetric Survey
Bathymetric Contours Measured in Feet
Four Foot Contour Intervals
Shoreline - 20 Foot
System Division into Basins
Backwater Lake
Geostatistical Properties of Basin
Maximum Depth Detected =6 Feet
Mean Depth = 2.89 Feet
Surface Area of Basin = 203.62 Acres
Volume of Basin = 589.46 Acre Feet
Geostatistical Properties of Basin
Maximum Depth Detected =22 Feet
Mean Depth = 5.48 Feet
Surface Area of Basin = 18.04 Acres
Volume of Basin = 98.91 Acre Feet
Kiser Lake
0.09 0.045 0 0.09 0.18 0.27 Miles
Scale 1:9,000
Map Projection: UTM Zone 16 (Meters) Datum: NAD83
Bathymetric Data: ©ReMetrix, LLC. 8/2001
www.remetrix.com
Image Source: USGS 1 Meter Orthophoto, 4/1998
611208
611508
611808
612108
612408
612708


XMap® 4.5
Inflow
Wetland Area
Inflow
Marina & Condos
Wetland Area
Inflow from Backwater
Webster outflow and control structure
Access Site
AQUATIC CONTROL
Webster Lake, Indiana
Lake Usage Map
Data use subject to license.
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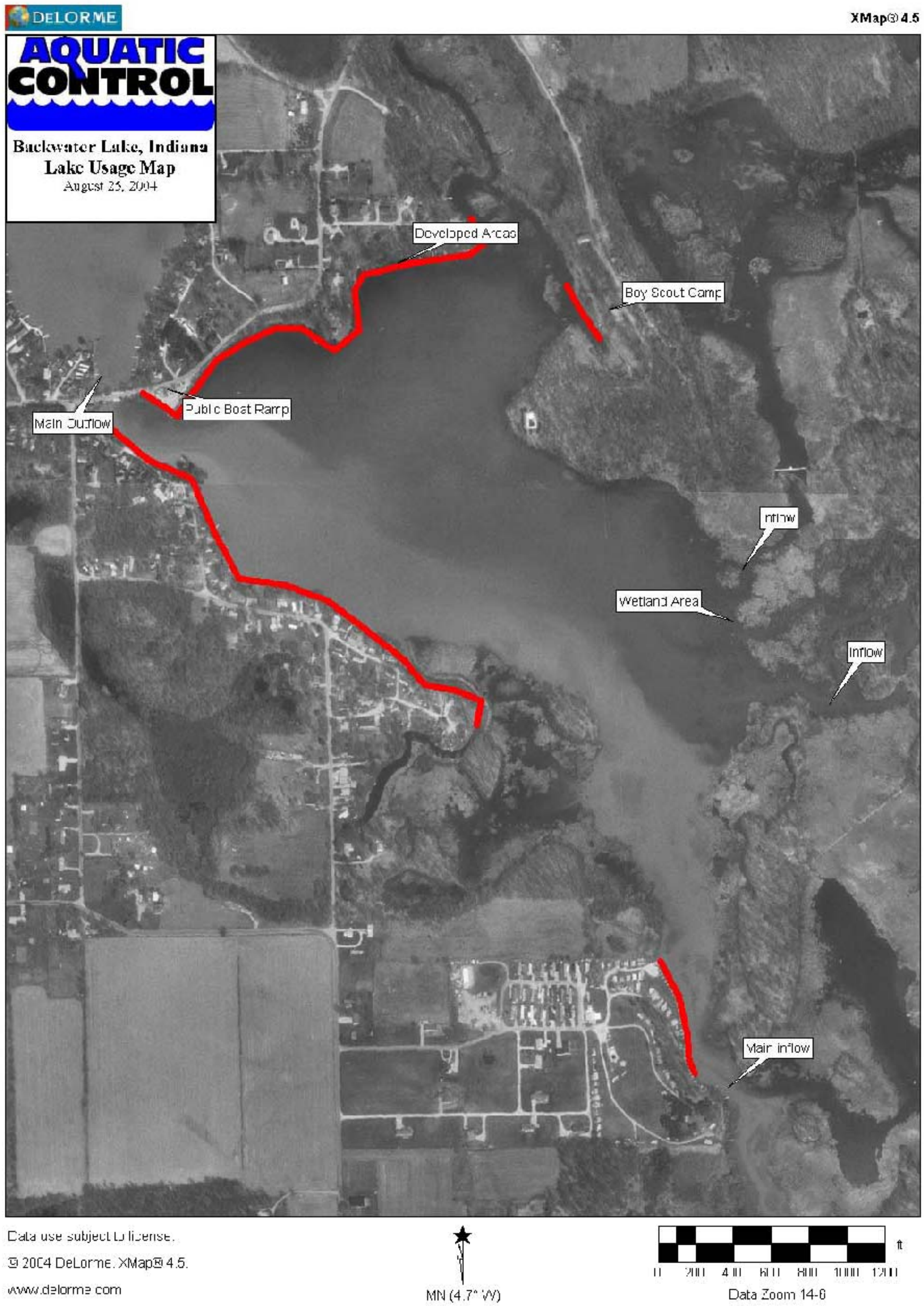
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AQUATIC CONTROL
Backwater Lake, Indiana
Lake Usage Map
August 25, 2004
Developed Areas
Boy Scout Camp
Public Boat Ramp
Main Outflow
Inflow
Wetland Area
Inflow
Main Inflow
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www.delorme.com
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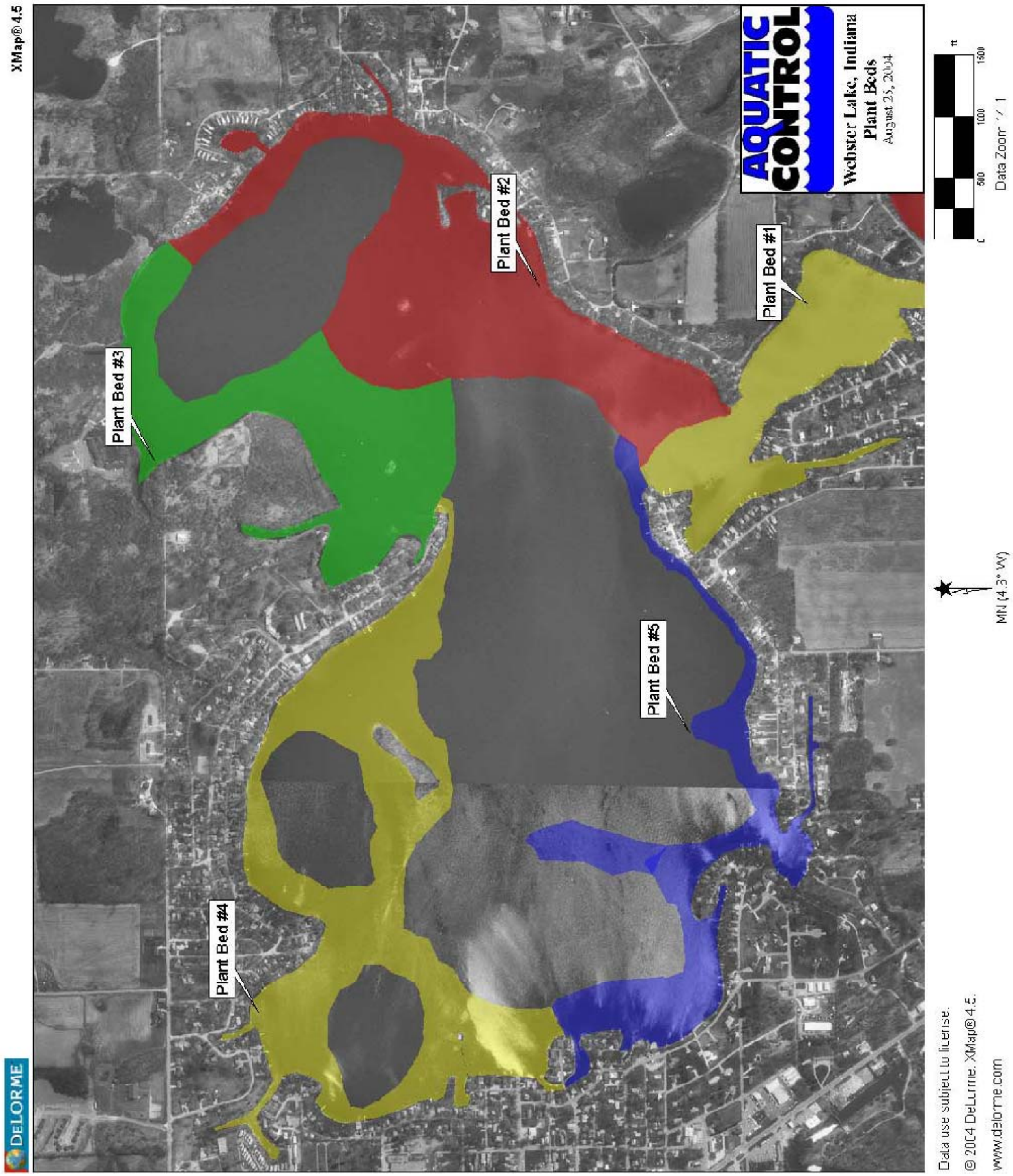
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Plant Bed #2
Plant Bed #3
Plant Bed #4
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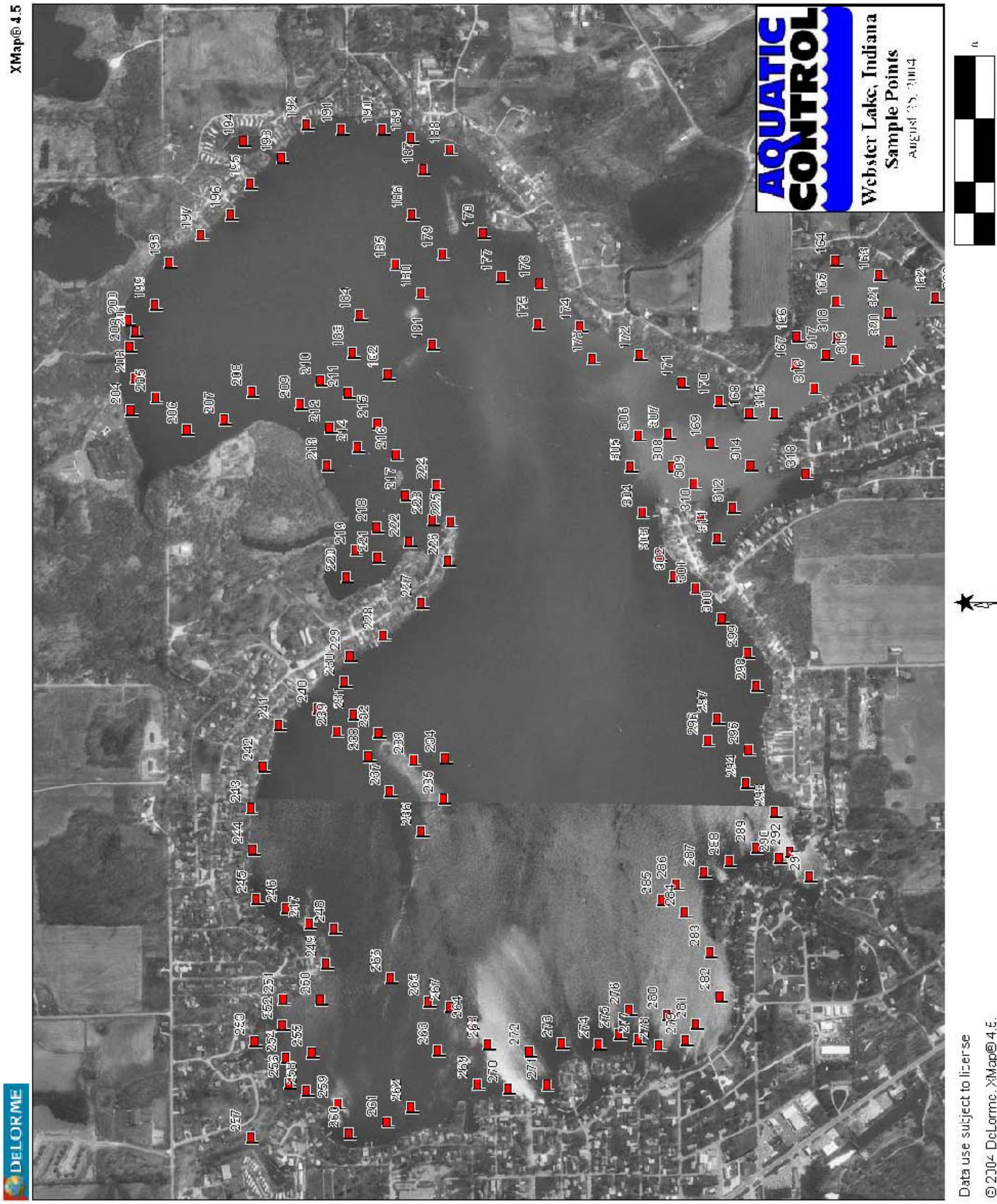
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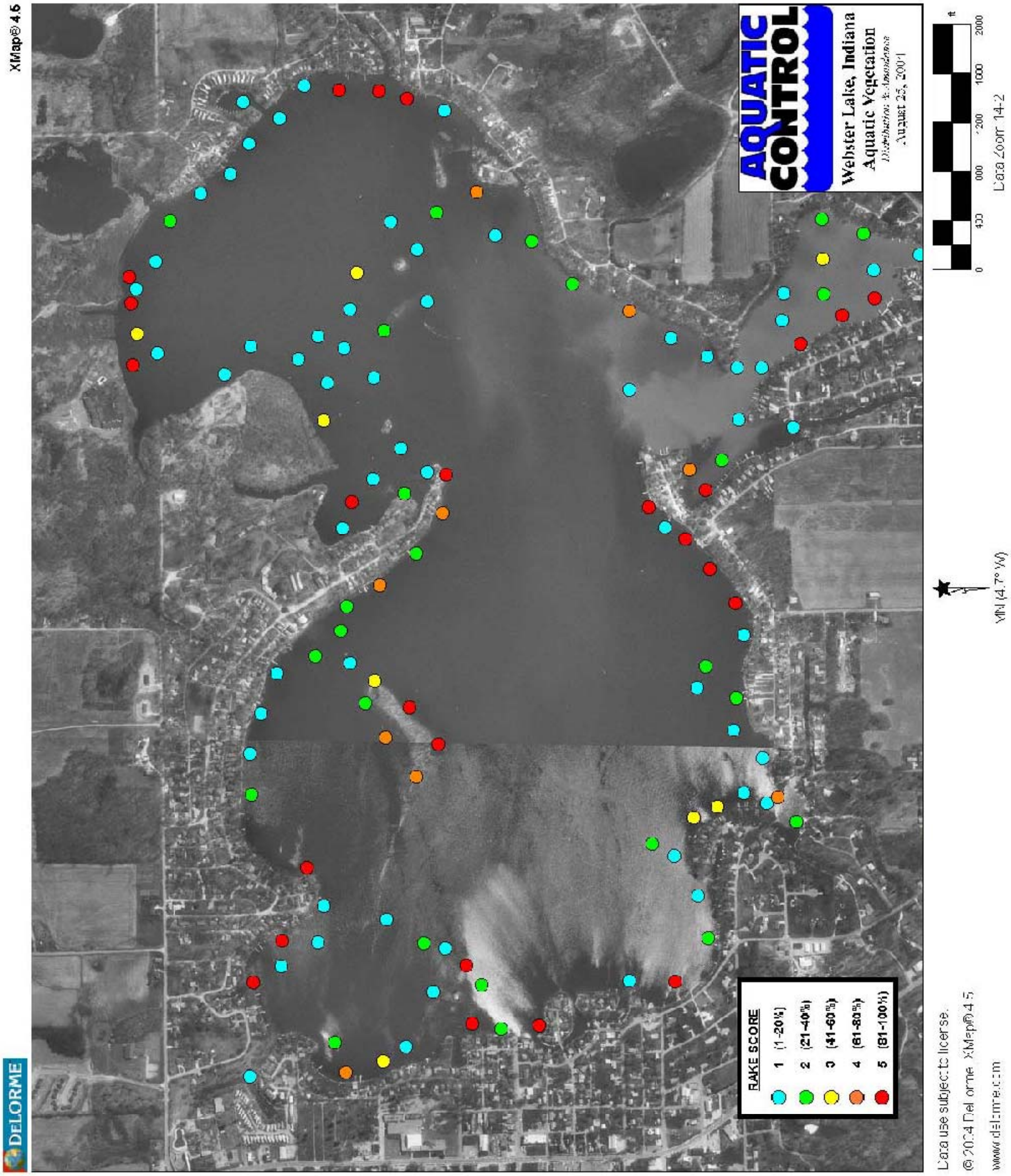
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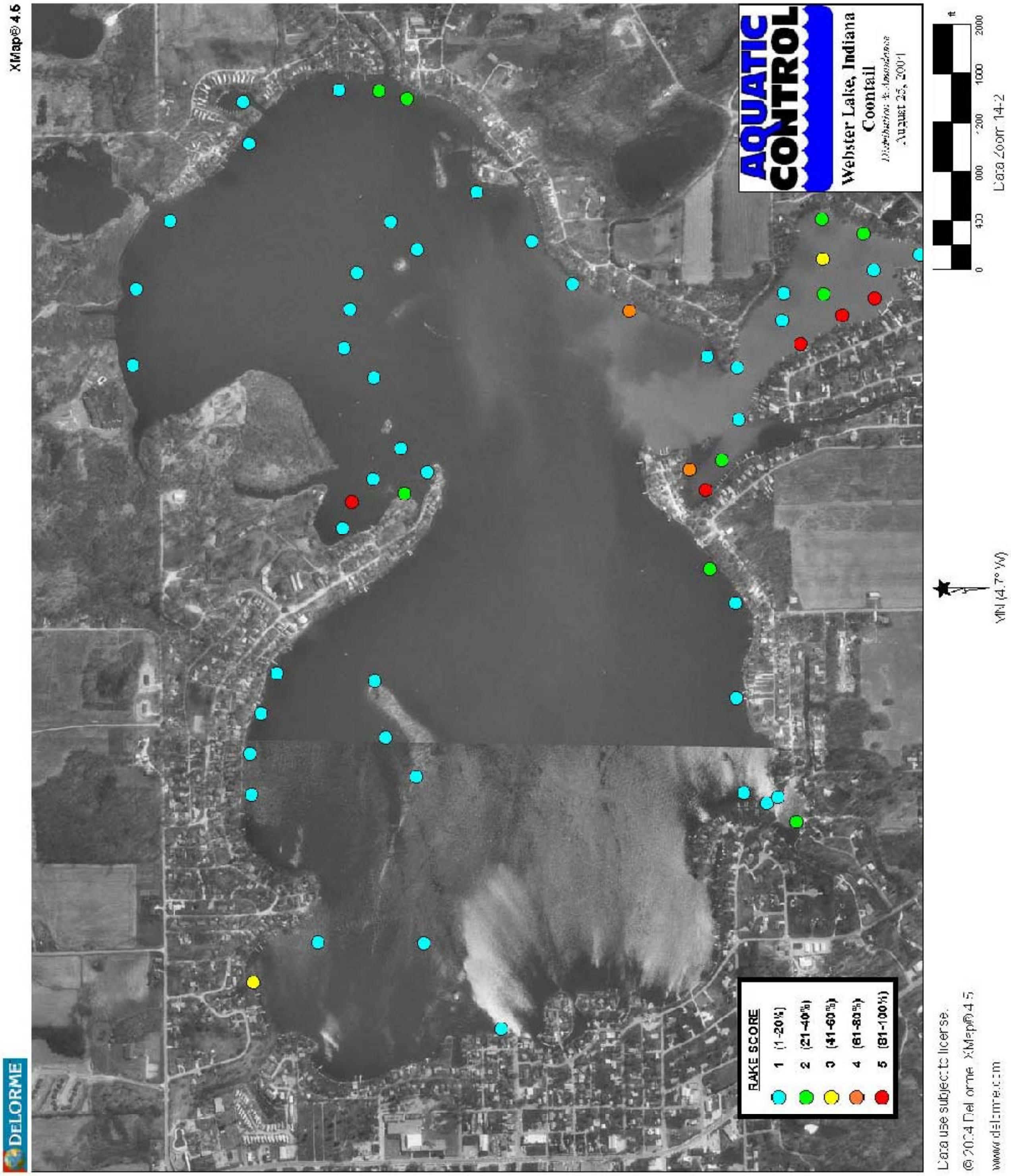
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Coontail
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RAKE SCORE
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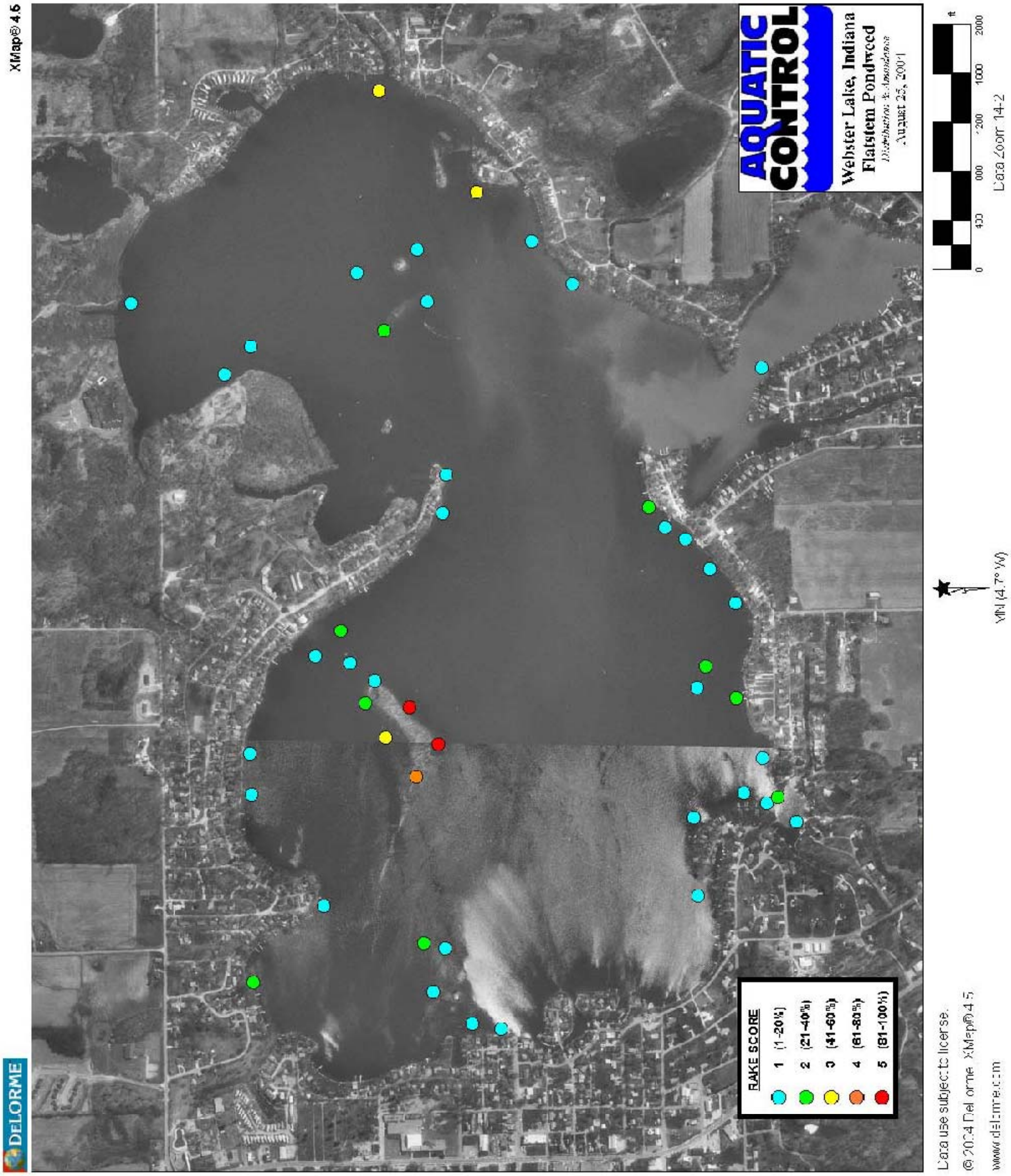
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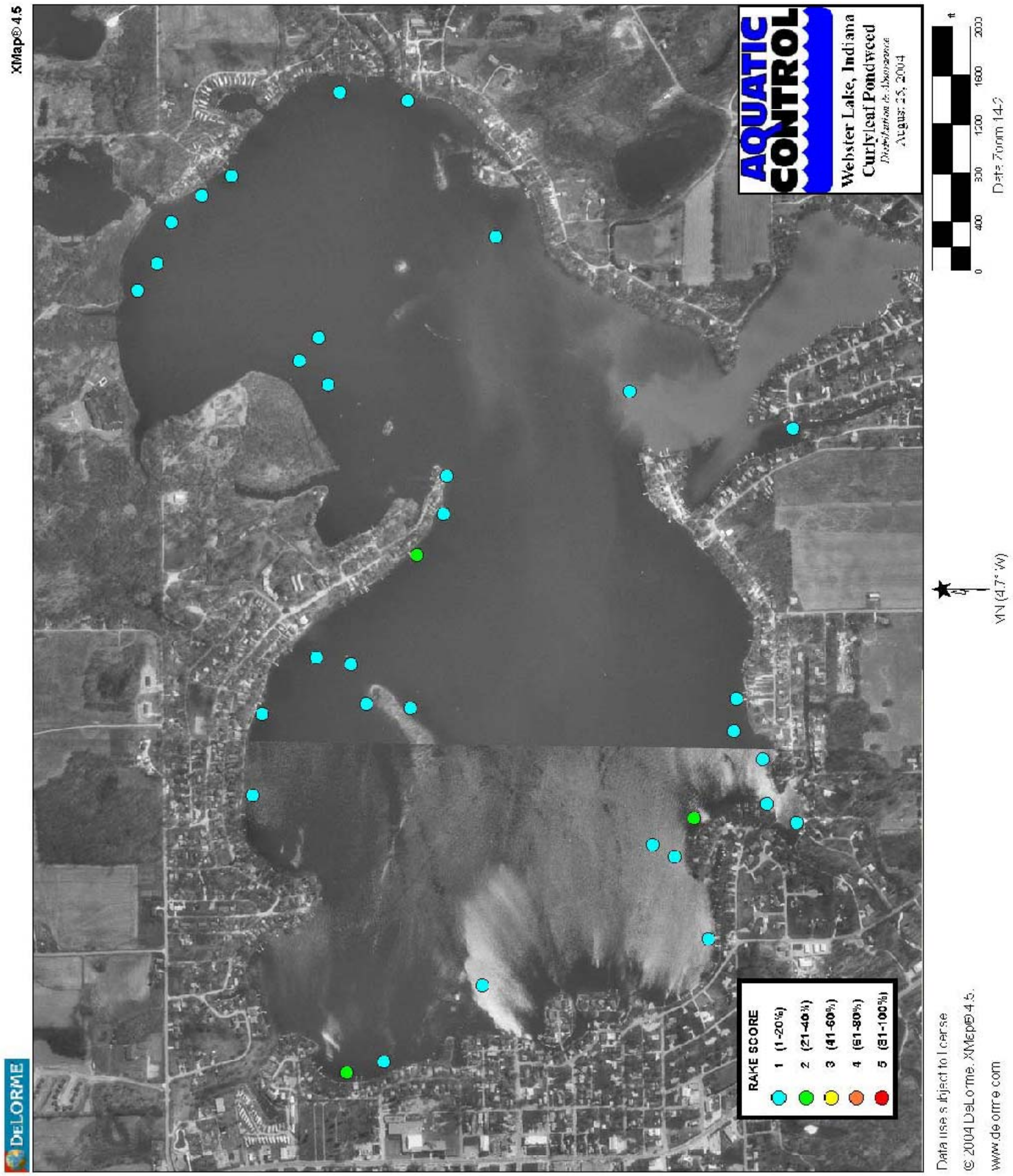
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Curlyleaf Pondweed
Distribution & Abundance
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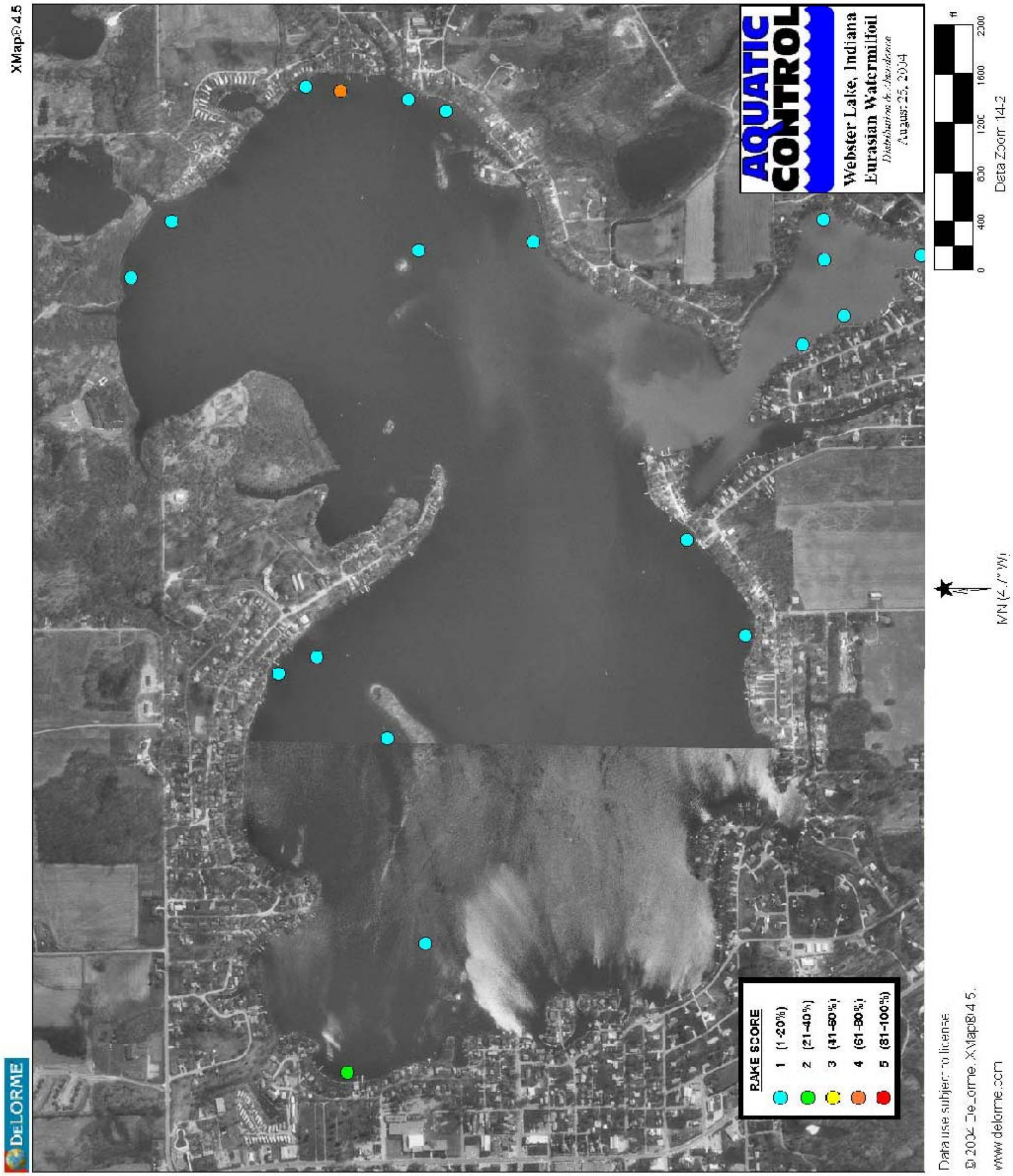
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Eurasian Watermilfoil
August 25, 2004
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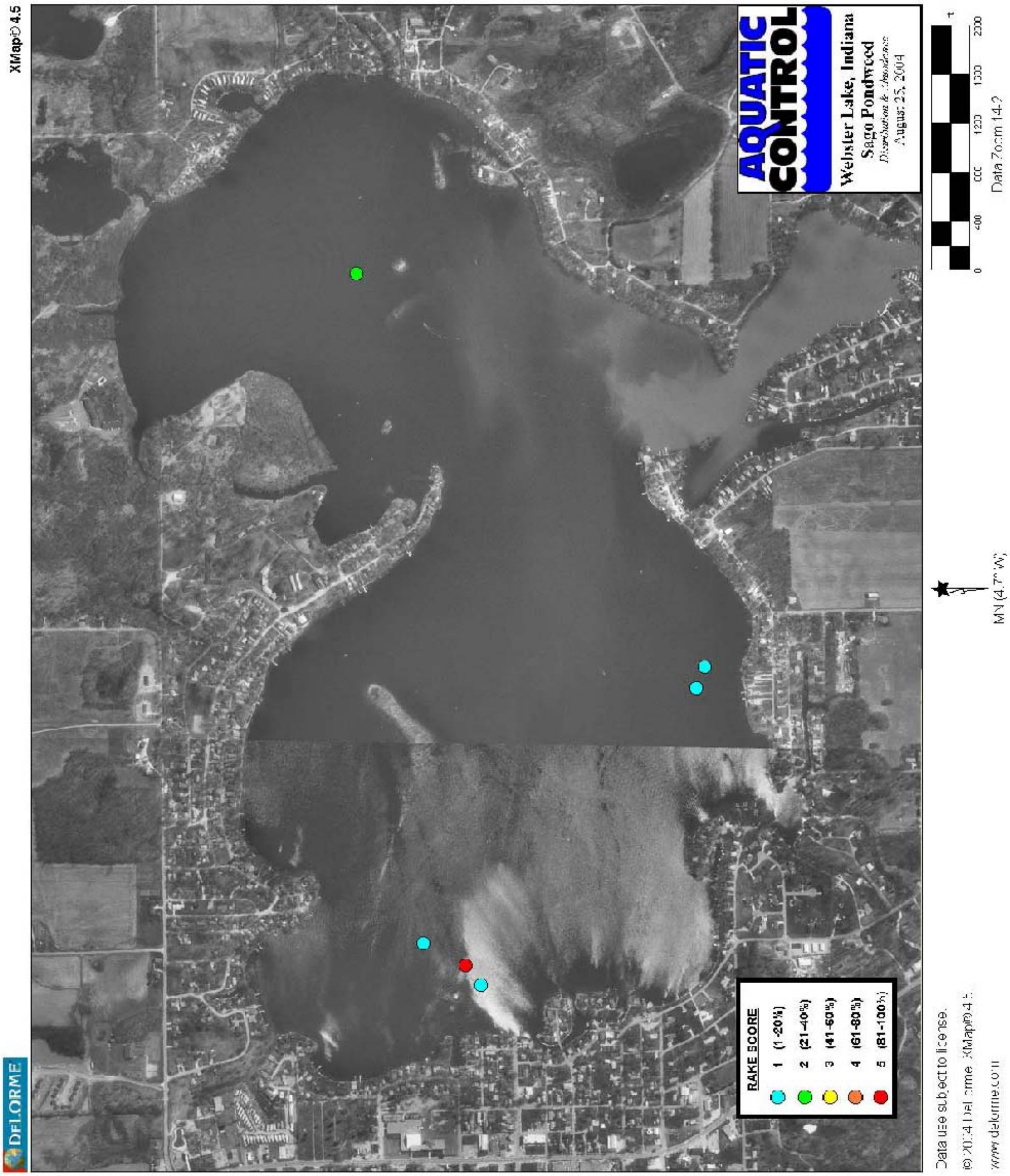
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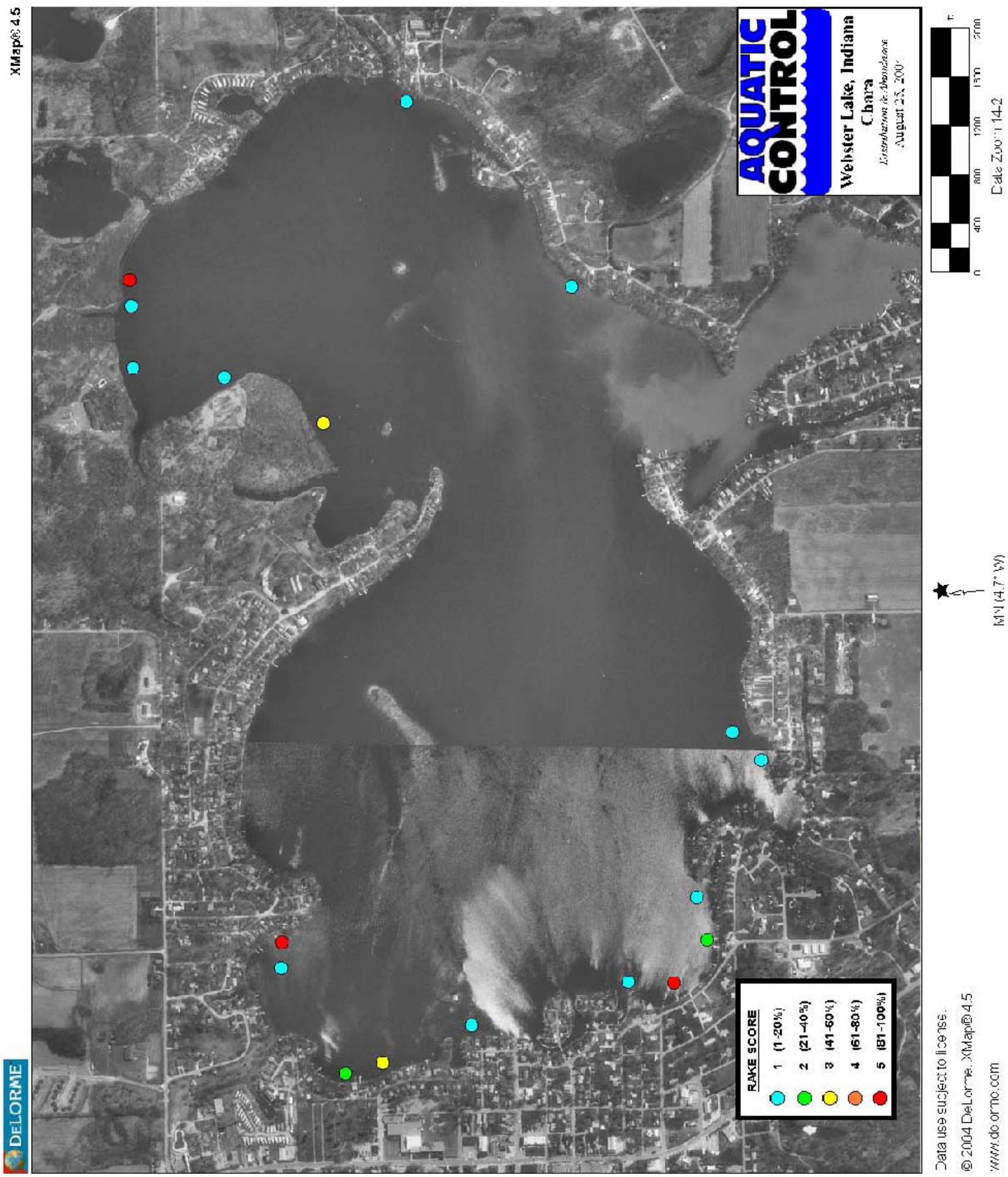
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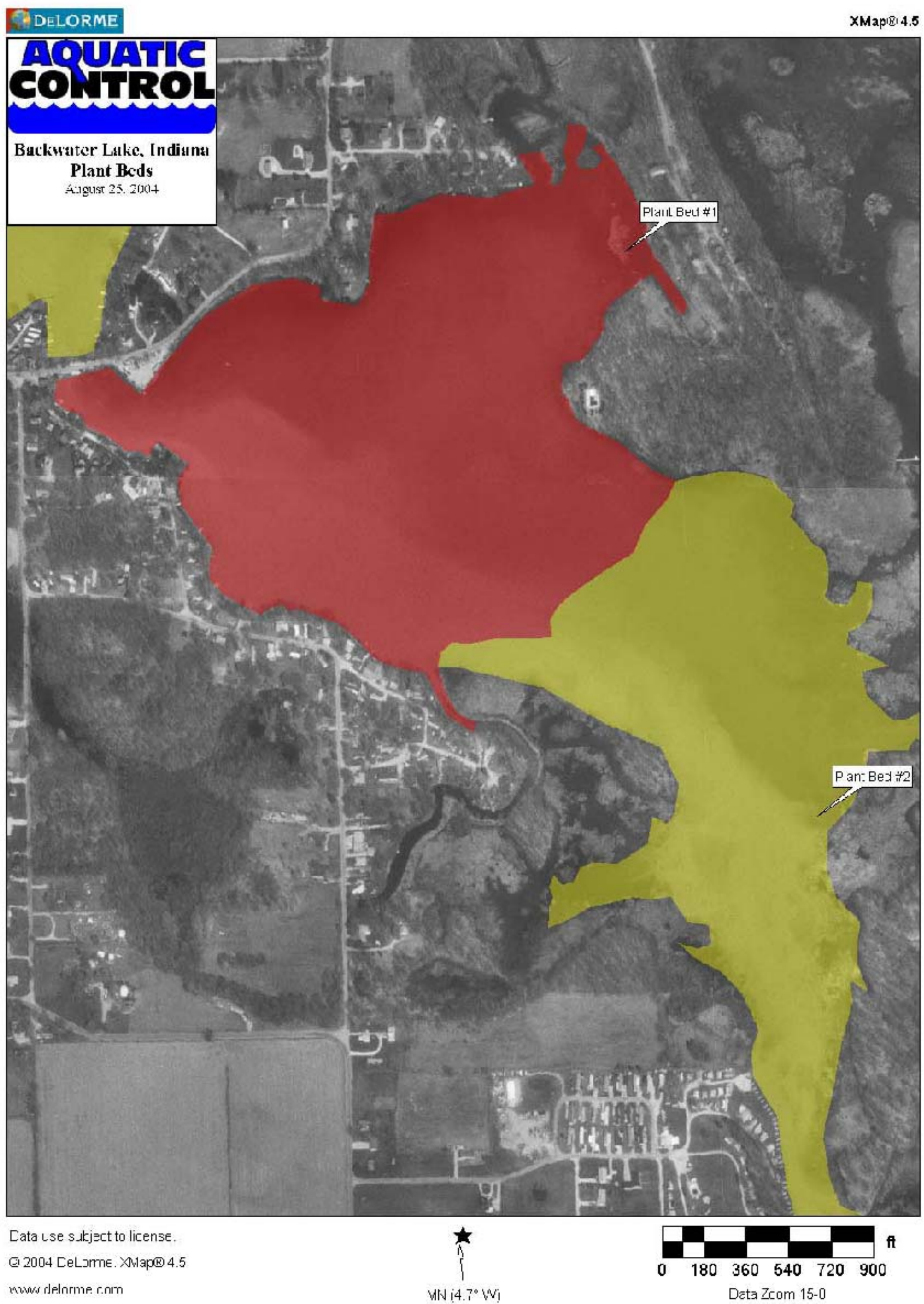
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August 25, 2004
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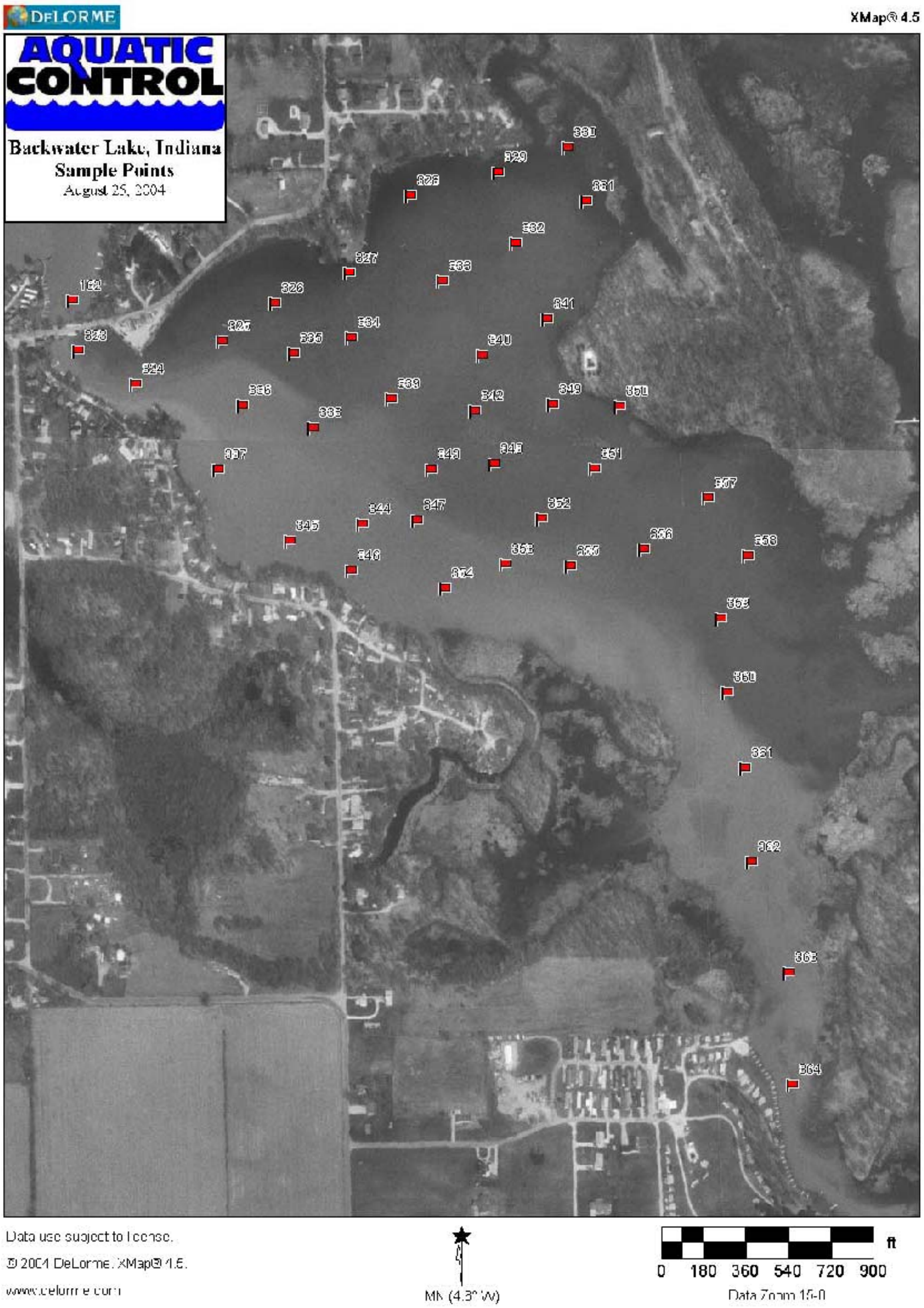
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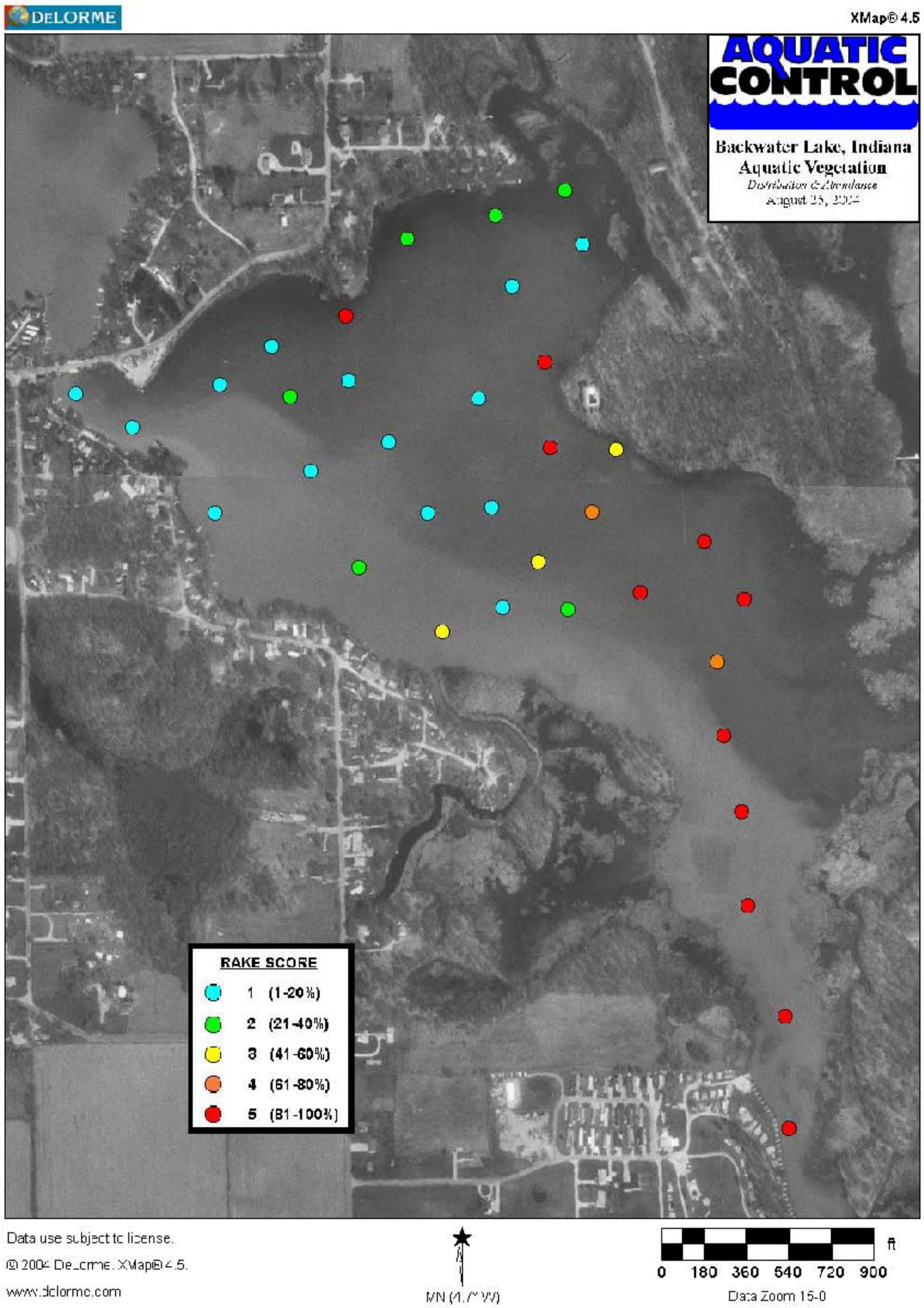
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Aquatic Vegetation
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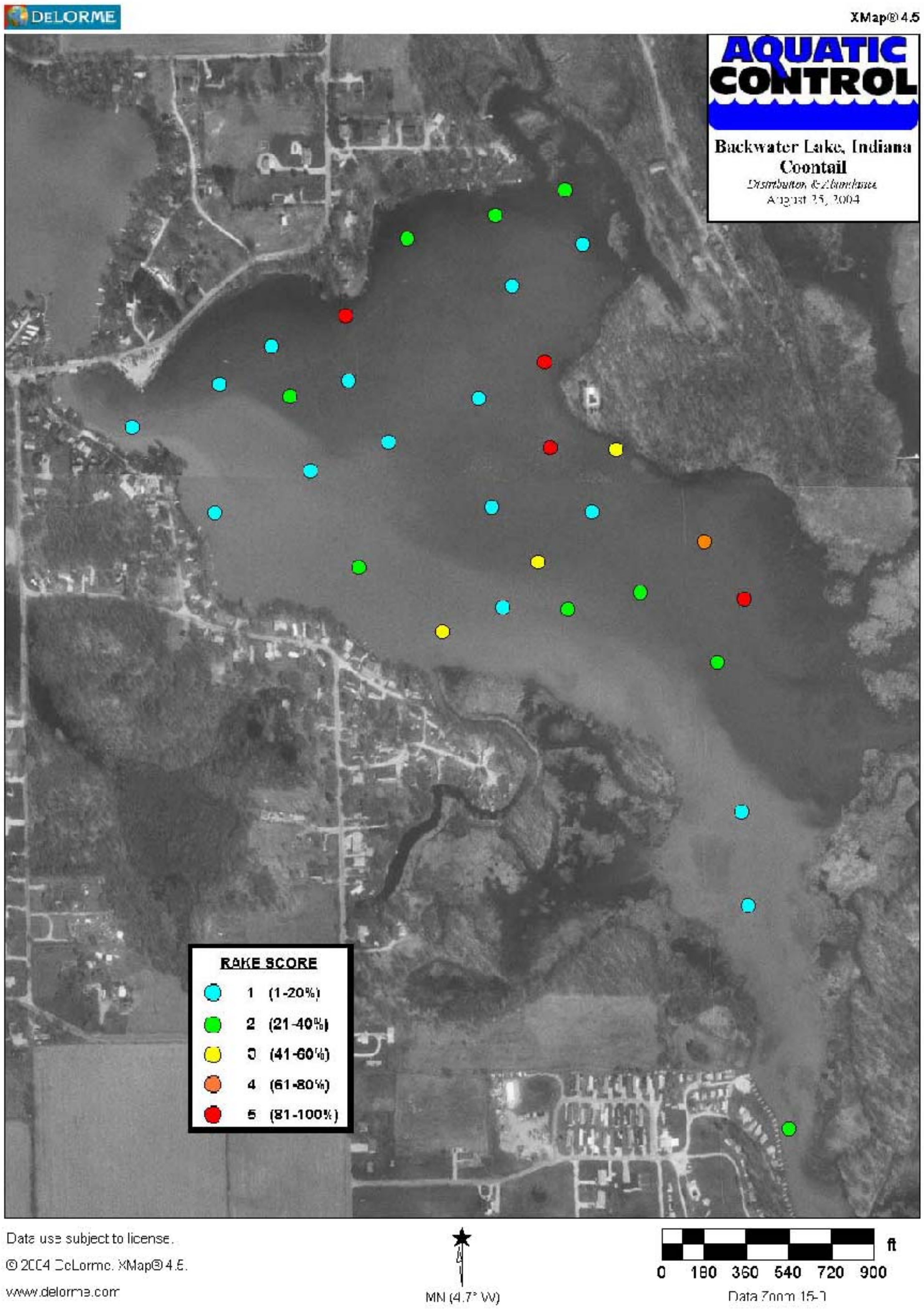
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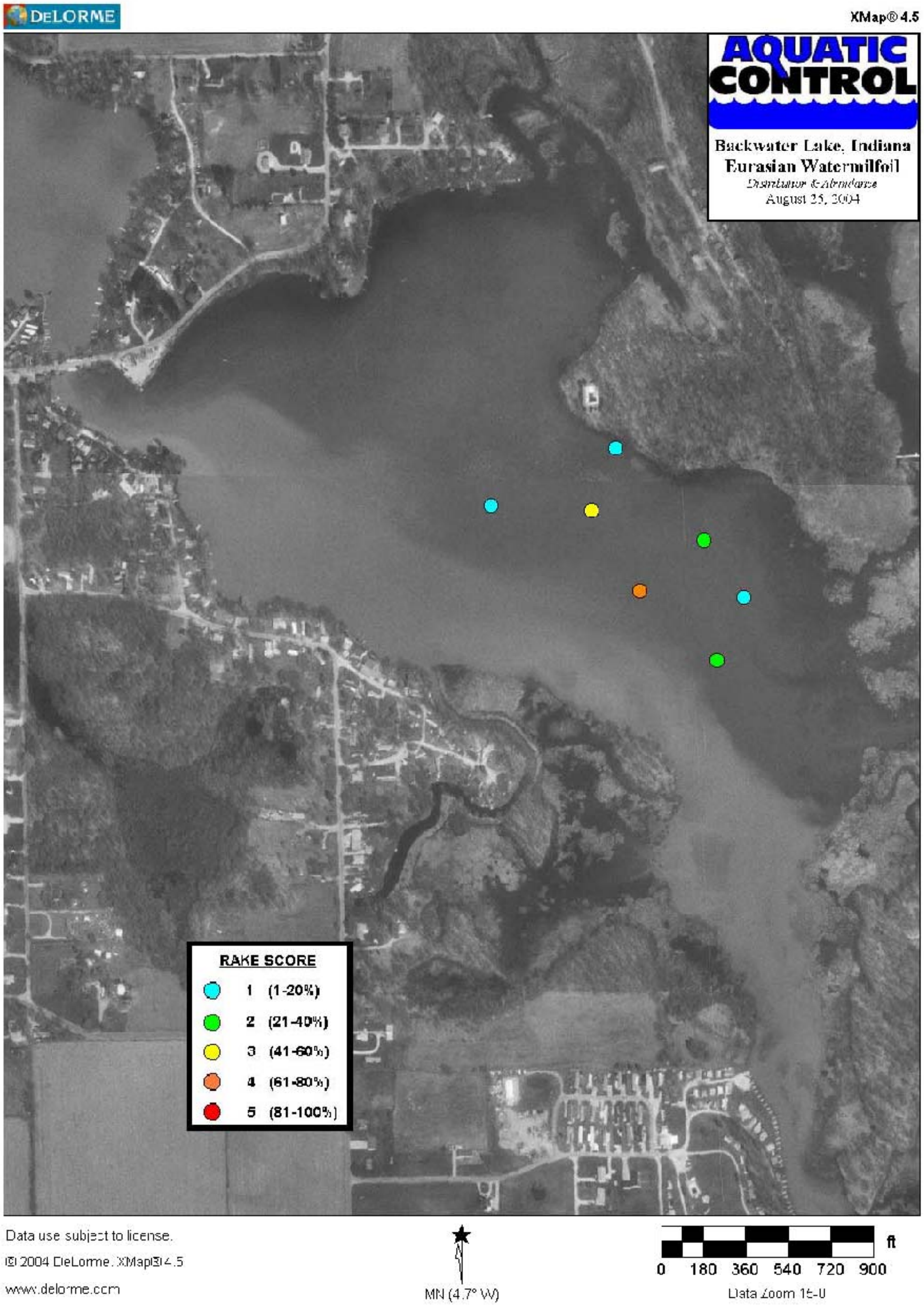
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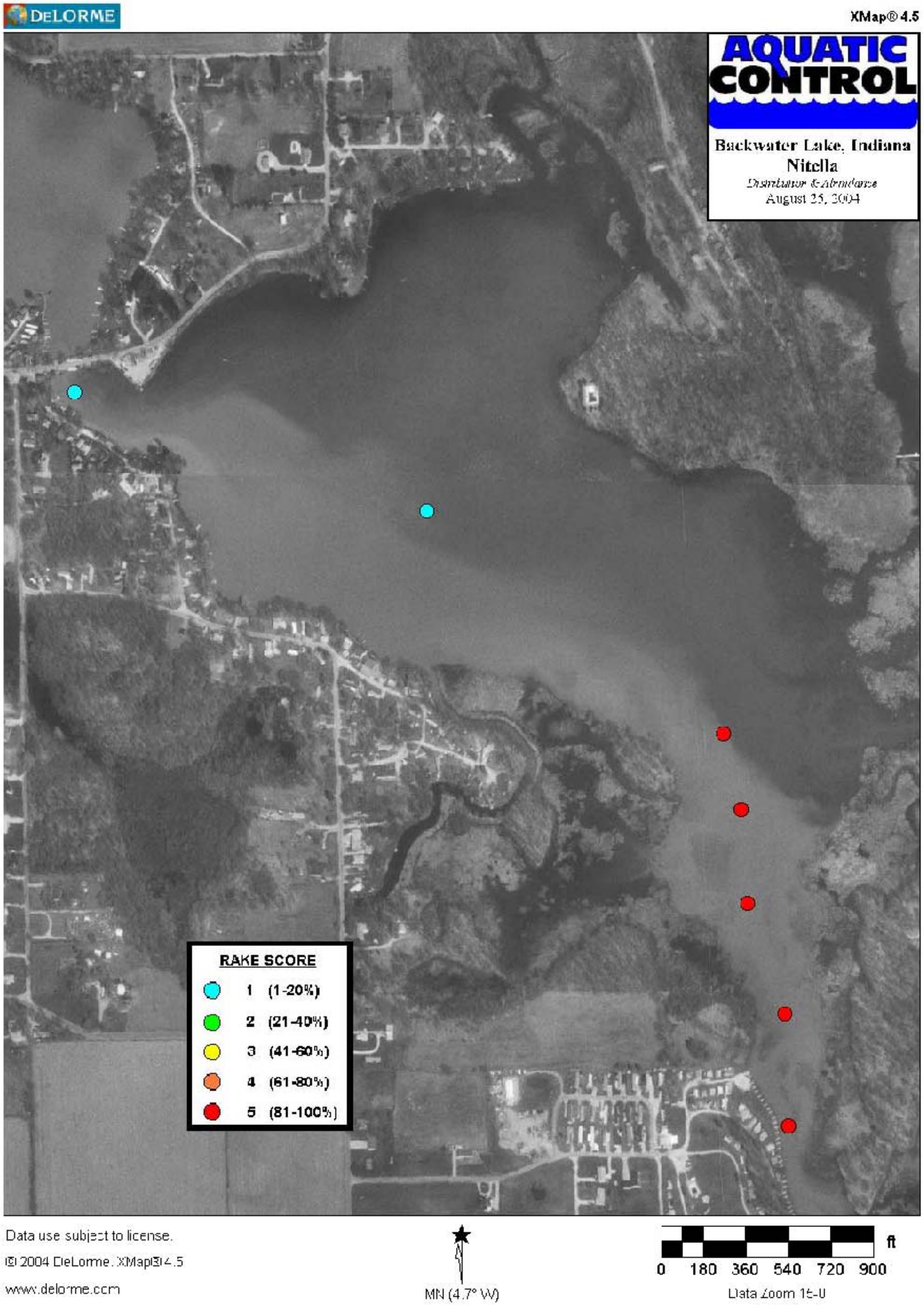
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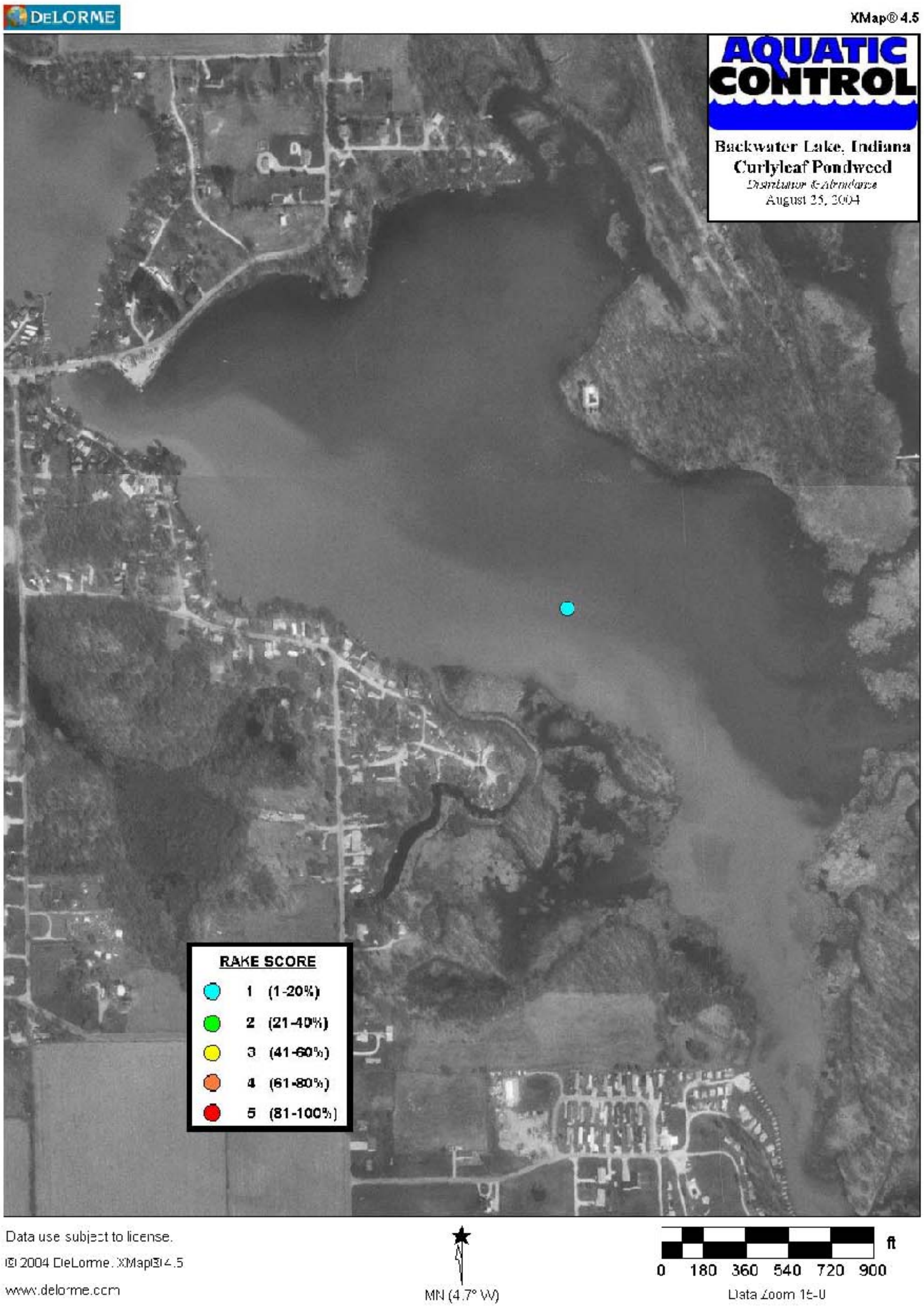
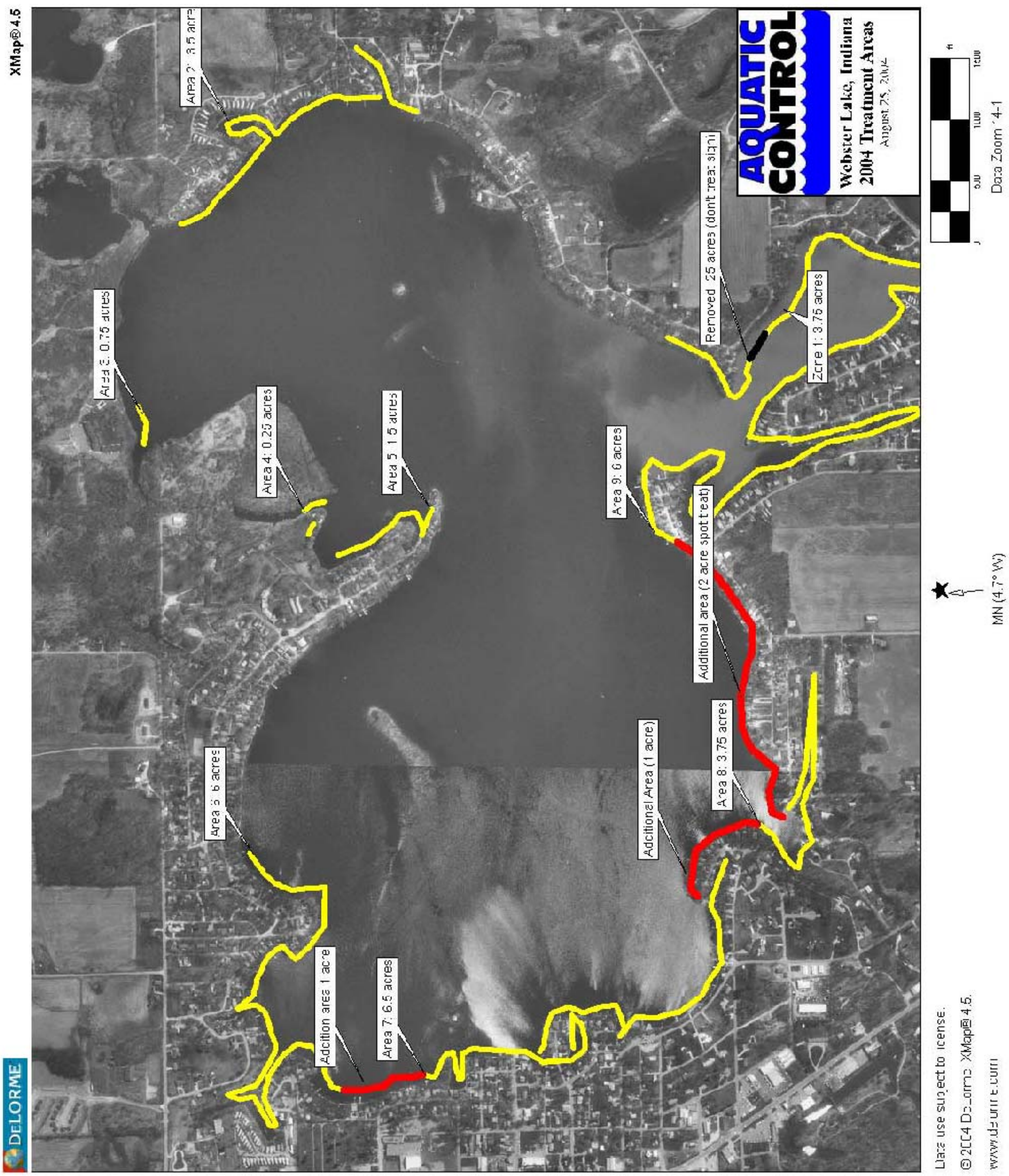
Nitella
Distribution & Abundance
August 25, 2004
RAKE SCORE
1 (1-20%)
2 (21-40%)
3 (41-60%)
4 (61-80%)
5 (81-100%)
Data use subject to license.
© 2004 DeLorme. XMap® 4.5
www.delorme.com
MN (4.7° W)
ft
0 180 360 540 720 900
Data Zoom 15-0


DELORME
XMap® 4.5
AQUATIC CONTROL
Backwater Lake, Indiana
Curlyleaf Pondweed
Distribution & Abundance
August 25, 2004
RAKE SCORE
1 (1-20%)
2 (21-40%)
3 (41-60%)
4 (61-80%)
5 (81-100%)
Data use subject to license.
© 2004 DeLorme. XMap® 4.5
www.delorme.com
MN (4.7° W)
0 180 360 540 720 900 ft
Data Zoom 15-0


XMap® 4.5
DELORME
Area 3: 0.75 acres
Area 4: 0.25 acres
Area 5: 1.5 acres
Area 9: 6 acres
Additional area (2 acre spot treat)
Zone 1: 3.75 acres
Area 8: 3.75 acres
Additional Area (1 acre)
Area 7: 6.5 acres
AQUATIC CONTROL
Webster Lake, Indiana
2004 Treatment Areas
MN (4.7° W)
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DeLORME
XMap® 4.5
AQUATIC CONTROL
Backwater Lake, Indiana
2004 Treatment Areas
August 25, 2004
Area 3
Area 4
Area 2
Data use subject to license.
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www.delorme.com
MN (4.7° W)
0 180 360 540 720 900
ft

Appendix C. Tier II Survey Data Sheets

Lake	Date	Latitude	Longitude	Site	Depth	RAKE	MYSP2	POCR3	CEDE4	CH?AR	NAFL	POPE6	POPU7	VAAM3	ELCA7	POZO	POIL	NAMA	ZODU	NI?TE	SpeNum	NatSpeNum
Webster	8/25/04	41.3167	-85.6711	162	6.0	1	1		1												2	1
Webster	8/25/04	41.31794	-85.6704	163	4.0	2			2												1	1
Webster	8/25/04	41.31887	-85.67	164	4.0	2	1		2												2	1
Webster	8/25/04	41.31886	-85.6712	165	5.0	3	1		3												2	1
Webster	8/25/04	41.31972	-85.6722	166	3.0	1			1												1	1
Webster	8/25/04	41.31975	-85.673	167	5.0	1			1												1	1
Webster	8/25/04	41.32076	-85.6744	168	4.0	1			1												1	1
Webster	8/25/04	41.3216	-85.6753	169	7.0	0															0	0
Webster	8/25/04	41.32142	-85.6741	170	3.0	1			1		1										2	2
Webster	8/25/04	41.32223	-85.6735	171	5.0	1															0	0
Webster	8/25/04	41.32316	-85.6727	172	4.0	4			4												1	1
Webster	8/25/04	41.32418	-85.6728	173	8.0	0															0	0
Webster	8/25/04	41.32444	-85.6719	174	4.0	2			1	1	2					1					4	4
Webster	8/25/04	41.32537	-85.6718	175	9.0	0															0	0
Webster	8/25/04	41.32533	-85.6707	176	4.0	2	1		1		2					1					4	3
Webster	8/25/04	41.32614	-85.6705	177	6.0	1		1													1	0
Webster	8/25/04	41.32656	-85.6692	178	4.0	4			1		1					3					3	3
Webster	8/25/04	41.32745	-85.6698	179	6.0	2					2										1	1
Webster	8/25/04	41.3279	-85.6709	180	8.0	1	1		1							1			1		4	3
Webster	8/25/04	41.32766	-85.6724	181	5.0	1					1					1			1		3	3
Webster	8/25/04	41.32863	-85.6733	182	6.0	2										2					1	1
Webster	8/25/04	41.32939	-85.6727	183	7.0	1			1												1	1
Webster	8/25/04	41.32923	-85.6716	184	7.0	3			1			2				1					3	3
Webster	8/25/04	41.32847	-85.6701	185	7.0	1			1												1	1
Webster	8/25/04	41.32811	-85.6686	186	6.0	0															0	0
Webster	8/25/04	41.32786	-85.6674	187	3.0	0															0	0
Webster	8/25/04	41.32728	-85.6668	188	2.0	1	1														1	0
Webster	8/25/04	41.32812	-85.6664	189	3.0	5	1	1	2	1	2										5	3
Webster	8/25/04	41.32874	-85.6662	190	4.0	5			2							3					2	2
Webster	8/25/04	41.32963	-85.6662	191	6.0	5	4	1	1												3	1
Webster	8/25/04	41.33041	-85.666	192	4.0	1	1				1										2	1
Webster	8/25/04	41.33094	-85.667	193	7.0	1					1										1	1
Webster	8/25/04	41.33177	-85.6665	194	8.0	1			1												1	1
Webster	8/25/04	41.33164	-85.6678	195	6.0	1			1												1	1
Webster	8/25/04	41.33205	-85.6686	196	5.0	1		1													1	0
Webster	8/25/04	41.33271	-85.6692	197	4.0	1		1													1	0
Webster	8/25/04	41.33339	-85.67	198	4.0	2	1	1	1												3	1
Webster	8/25/04	41.33371	-85.6713	199	5.0	1		1													1	0
Webster	8/25/04	41.33429	-85.6717	200	2.0	5	1			5											2	1
Webster	8/25/04	41.33414	-85.672	201	4.0	1		1	1												2	1
Webster	8/25/04	41.33425	-85.6725	202	3.0	5				1	5					1		5			4	4
Webster	8/25/04	41.33413	-85.6734	203	4.0	3												3			1	1
Webster	8/25/04	41.33423	-85.6743	204	3.0	5			1	1								5			3	3
Webster	8/25/04	41.33368	-85.674	205	6.0	1													1		1	1
Webster	8/25/04	41.333	-85.6749	206	4.0	0															0	0
Webster	8/25/04	41.33219	-85.6746	207	4.0	1				1						1					2	2
Webster	8/25/04	41.33159	-85.6738	208	6.0	1										1			1		2	2
Webster	8/25/04	41.33054	-85.6741	209	6.0	1		1													1	0
Webster	8/25/04	41.33009	-85.6735	210	8.0	1		1													1	0
Webster	8/25/04	41.32951	-85.6738	211	10.0	1			1												1	1
Webster	8/25/04	41.32989	-85.6748	212	4.0	1		1													1	0
Webster	8/25/04	41.32997	-85.6759	213	3.0	3				3											1	1
Webster	8/25/04	41.3293	-85.6754	214	5.0	0															0	0
Webster	8/25/04	41.32885	-85.6747	215	10.0	1			1												1	1
Webster	8/25/04	41.32845	-85.6756	216	10.0	0															0	0
Webster	8/25/04	41.32824	-85.6768	217	5.0	1			1												1	1
Webster	8/25/04	41.32886	-85.6777	218	5.0	1			1		1										2	2
Webster	8/25/04	41.32934	-85.6784	219	4.0	5			5												1	1
Webster	8/25/04	41.32955	-85.6792	220	4.0	1			1												1	1
Webster	8/25/04	41.32885	-85.6786	221	4.0	0															0	0
Webster	8/25/04	41.32817	-85.6781	222	4.0	2			2												1	1
Webster	8/25/04	41.32766	-85.6775	223	2.0	1			1												1	1
Webster	8/25/04	41.32757	-85.6765	224	11.0	0															0	0
Webster	8/25/04	41.32725	-85.6776	225	2.0	5		1					4			1					3	2
Webster	8/25/04	41.32731	-85.6787	226	8.0	4		1			1		3			1					4	3
Webster	8/25/04	41.3279	-85.6799	227	9.0	2		2													1	0
Webster	8/25/04	41.32872	-85.6808	228	6.0	4					4										1	1
Webster	8/25/04	41.32945	-85.6815	229	4.0	2					2				2						2	2
Webster	8/25/04	41.32958	-85.6822	230	9.0	2					1					2					2	2
Webster	8/25/04	41.32938	-85.6831	231	9.0	1		1								1					2	1
Webster	8/25/04	41.32883	-85.6837	232	4.0	3			1		2					1					3	3
Webster	8/25/04	41.32806	-85.6845	233	5.0	5		1			1					5					3	2
Webster	8/25/04	41.32739	-85.6844	234	10.0	0															0	0
Webster	8/25/04	41.32741	-85.6856	235	3.0	5					2					5					2	2
Webster	8/25/04	41.3279	-85.6865	236	12.0	4			1		1					4					3	3
Webster	8/25/04	41.32859	-85.6854	237	9.0	4	1		1							3					3	2
Webster	8/25/04	41.32904	-85.6844	238	4.0	2		1								2					2	1
Webster	8/25/04	41.32973	-85.6836	239	13.0	0															0	0
Webster	8/25/04	41.33016	-85.683	240	8.0	2	1	1								1					3	1
Webster	8/25/04	41.33101	-85.6835	241	5.0	1	1		1												2	1
Webster	8/25/04	41.33136	-85.6846	242	6.0	1		1	1				1								3	2
Webster	8/25/04	41.33162	-85.6859	243	6.0	1			1							1					2	2
Webster	8/25/04	41.33158	-85.6871	244	9.0	2		1	1				1			1			1		5	4
Webster	8/25/04	41.33149	-85.6885	245	4.0	0															0	0
Webster	8/25/04	41.33085	-85.6888	246	11.0	0															0	0

Species Codes	
BIBE	Bur marigold
CEDE4	Coontail
CH?AR	Chara
ELCA7	Elodea
LEMN	Duckweeds
MYHE	Broadleaf watermilfoil
MYSI	Northern watermilfoil
MYSP2	Eurasian watermilfoil
MYVE	Whorled watermilfoil
NAFL	Slender naiad
NAGU	Southern waternymph
NAMA	Spiny naiad
NAMI	Brittle waternymph
NELU	American lotus
NI?TE	Nitella
NOAQVG	No aquatic vegetation
NULU	Yellow pond lily
NYTU	White water lily
POAM	Large-leaf pondweed
POCR3	Curly-leaf pondweed
POFO3	Leafy pondweed
POGR8	Variable pondweed
POIL	Illinois pondweed
PONO2	American pondweed
POPE6	Sago pondweed
POPR5	White-stemmed pondweed
POPU7	Small pondweed
PORI2	Richardson's pondweed
POZO	Flat-stemmed pondweed
UTMA	Common bladderwort
VAAM3	Wild celery, eel grass
WO?LF	Watermeal
ZAPA	Horned pondweed
ZODU	Water stargrass
Count	34

Lake	Date	Latitude	Longitude	Site	Depth	RAKE	MYSP2	POCR3	CEDE4	CH?AR	NAFL	POPE6	POPU7	VAAM3	ELCA7	POZO	POIL	NAMA	ZODU	NI?TE	SpeNum	NatSpeNum
Webster	8/25/04	41.33034	-85.6892	247	4.0	5					5								1		2	2
Webster	8/25/04	41.32979	-85.6893	248	9.0	0															0	0
Webster	8/25/04	41.32998	-85.6904	249	6.0	1					1					1					2	2
Webster	8/25/04	41.33011	-85.6914	250	8.0	1			1												1	1
Webster	8/25/04	41.3309	-85.6914	251	4.0	5				5	1										2	2
Webster	8/25/04	41.33092	-85.6921	252	5.0	1				1											1	1
Webster	8/25/04	41.33153	-85.6926	253	3.0	5			3		1					2					3	3
Webster	8/25/04	41.33084	-85.6931	254	6.0	0															0	0
Webster	8/25/04	41.33028	-85.6929	255	7.0	0															0	0
Webster	8/25/04	41.33079	-85.6938	256	4.0	0															0	0
Webster	8/25/04	41.33161	-85.6954	257	3.0	1														1	0	0
Webster	8/25/04	41.33041	-85.6941	258	4.0	0															0	0
Webster	8/25/04	41.32972	-85.6944	259	8.0	2											2				1	1
Webster	8/25/04	41.32947	-85.6953	260	4.0	4	2	2		2											3	1
Webster	8/25/04	41.32865	-85.695	261	6.0	3		1		3											2	1
Webster	8/25/04	41.32813	-85.6945	262	5.0	1					1										1	1
Webster	8/25/04	41.32753	-85.6929	263	6.0	1										1					1	1
Webster	8/25/04	41.3268	-85.6921	264	9.0	5						5							1		2	2
Webster	8/25/04	41.32774	-85.6915	265	9.0	2	1		1			1				2					4	3
Webster	8/25/04	41.32857	-85.6908	266	9.0	1							1								1	1
Webster	8/25/04	41.32727	-85.6916	267	8.0	1										1					1	1
Webster	8/25/04	41.32645	-85.6927	268	7.0	2		1			1	1									3	2
Webster	8/25/04	41.32667	-85.6939	269	4.0	5				1	5					1			1		4	4
Webster	8/25/04	41.32602	-85.694	270	4.0	2			1		2					1					3	3
Webster	8/25/04	41.32517	-85.6939	271	6.0	5					5		2								2	2
Webster	8/25/04	41.32554	-85.6929	272	7.0	0															0	0
Webster	8/25/04	41.32484	-85.6927	273	6.0	0															0	0
Webster	8/25/04	41.32403	-85.6927	274	4.0	0															0	0
Webster	8/25/04	41.32359	-85.6924	275	6.0	0															0	0
Webster	8/25/04	41.32337	-85.6917	276	6.0	0															0	0
Webster	8/25/04	41.32317	-85.6926	277	5.0	1				1											1	1
Webster	8/25/04	41.32273	-85.6927	278	4.0	0															0	0
Webster	8/25/04	41.32213	-85.6926	279	3.0	5				5											1	1
Webster	8/25/04	41.32255	-85.6918	280	5.0	0															0	0
Webster	8/25/04	41.32192	-85.6921	281	4.0	0															0	0
Webster	8/25/04	41.3214	-85.6913	282	3.0	2		1		2											2	1
Webster	8/25/04	41.32162	-85.69	283	4.0	1				1						1					2	2
Webster	8/25/04	41.32215	-85.6889	284	6.0	1		1													1	0
Webster	8/25/04	41.32266	-85.6885	285	10.0	2		1			1		1								3	2
Webster	8/25/04	41.32234	-85.6881	286	9.0	0															0	0
Webster	8/25/04	41.32173	-85.6877	287	7.0	3		2								1					2	1
Webster	8/25/04	41.32119	-85.6874	288	4.0	3					3										1	1
Webster	8/25/04	41.32061	-85.687	289	9.0	1			1		1					1					3	3
Webster	8/25/04	41.3201	-85.6873	290	6.0	1		1	1							1					3	2
Webster	8/25/04	41.31944	-85.6879	291	8.0	2		1	2							1					3	2
Webster	8/25/04	41.31986	-85.6871	292	6.0	4			1				2			2					3	3
Webster	8/25/04	41.3202	-85.686	293	4.0	1		1		1						1					3	2
Webster	8/25/04	41.32084	-85.6852	294	8.0	1		1		1											2	1
Webster	8/25/04	41.32077	-85.6842	295	6.0	2		1	1							2					3	2
Webster	8/25/04	41.32166	-85.6839	296	9.0	1						1				1					2	2
Webster	8/25/04	41.32147	-85.6833	297	10.0	2						1				2					2	2
Webster	8/25/04	41.32061	-85.6823	298	6.0	1	1														1	0
Webster	8/25/04	41.3208	-85.6814	299	7.0	5			1		3		1			1					4	4
Webster	8/25/04	41.32136	-85.6804	300	6.0	5			2		2		1			1			2		5	5
Webster	8/25/04	41.32192	-85.6795	301	4.0	5	1				5		1			1					4	3
Webster	8/25/04	41.32238	-85.6791	302	12.0	1										1					1	1
Webster	8/25/04	41.32273	-85.6785	303	4.0	5					1		2			2					3	3
Webster	8/25/04	41.32309	-85.6773	304	5.0	0															0	0
Webster	8/25/04	41.32335	-85.676	305	7.0	0															0	0
Webster	8/25/04	41.32317	-85.6751	306	7.0	1		1													1	0
Webster	8/25/04	41.32253	-85.675	307	7.0	0															0	0
Webster	8/25/04	41.32243	-85.676	308	6.0	0															0	0
Webster	8/25/04	41.32196	-85.6764	309	4.0	0															0	0
Webster	8/25/04	41.32181	-85.6774	310	4.0	4			4												1	1
Webster	8/25/04	41.32146	-85.678	311	4.0	5			5												1	1
Webster	8/25/04	41.3211	-85.6771	312	3.0	2			2												1	1
Webster	8/25/04	41.31952	-85.6761	313	4.0	1		1												1	1	0
Webster	8/25/04	41.32072	-85.6759	314	4.0	1			1												1	1
Webster	8/25/04	41.32021	-85.6744	315	4.0	1					1					1					2	2
Webster	8/25/04	41.31935	-85.6737	316	5.0	5	1		5												2	1
Webster	8/25/04	41.31907	-85.6727	317	5.0	0															0	0
Webster	8/25/04	41.31883	-85.6722	318	5.0	2			2												1	1
Webster	8/25/04	41.31843	-85.6728	319	3.0	5	1		5												2	1
Webster	8/25/04	41.3177	-85.6723	320	4.0	5			5												1	1
Webster	8/25/04	41.31772	-85.6715	321	4.0	1			1												1	1

Species Codes	
BIBE	Bur marigold
CEDE4	Coontail
CH?AR	Chara
ELCA7	Elodea
LEMN	Duckweeds
MYHE	Broadleaf watermilfoil
MYSI	Northern watermilfoil
MYSP2	Eurasian watermilfoil
MYVE	Whorled watermilfoil
NAFL	Slender naiad
NAGU	Southern waternymph
NAMA	Spiny naiad
NAMI	Brittle waternymph
NELU	American lotus
NI?TE	Nitella
NOAQVG	No aquatic vegetation
NULU	Yellow pond lily
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PORI2	Richardson's pondweed
POZO	Flat-stemmed pondweed
UTMA	Common bladderwort
VAAM3	Wild celery, eel grass
WO?LF	Watermeal
ZAPA	Horned pondweed
ZODU	Water stargrass
Count	34

Lake	Date	Latitude	Longitude	Site	Depth	RAKE	MYSP2	POCR3	CEDE4	CH?AR	NI?TE	SpeNum	NatSpeNum		Species Codes	
Backwater	8/25/04	41.31612	-85.67096	323	5.0	1					1	0	0		BIBE	Bur marigold
Backwater	8/25/04	41.31573	-85.67009	324	4.0	1			1			1	1		CEDE4	Coontail
Backwater	8/25/04	41.31622	-85.66874	325	9.0	1			1			1	1		CH?AR	Chara
Backwater	8/25/04	41.31666	-85.66793	326	5.0	1			1			1	1		ELCA7	Elodea
Backwater	8/25/04	41.31701	-85.66679	327	3.0	5			5			1	1		LEMN	Duckweeds
Backwater	8/25/04	41.31791	-85.66584	328	3.0	2			2			1	1		MYHE	Broadleaf watermilfoil
Backwater	8/25/04	41.31818	-85.6645	329	3.0	2			2			1	1		MYSI	Northern watermilfoil
Backwater	8/25/04	41.31846	-85.66342	330	2.0	2			2			1	1		MYSP2	Eurasian watermilfoil
Backwater	8/25/04	41.31785	-85.66315	331	2.0	1			1			1	1		MYVE	Whorled watermilfoil
Backwater	8/25/04	41.31736	-85.66423	332	3.0	1			1			1	1		NAFL	Slender naiad
Backwater	8/25/04	41.31692	-85.66536	333	3.0	0						0	0		NAGU	Southern waternymph
Backwater	8/25/04	41.31627	-85.66676	334	5.0	1			1			1	1		NAMA	Spiny naiad
Backwater	8/25/04	41.31608	-85.66765	335	6.0	2			2			1	1		NAMI	Brittle waternymph
Backwater	8/25/04	41.31549	-85.66844	336	5.0	0						0	0		NELU	American lotus
Backwater	8/25/04	41.31474	-85.66881	337	4.0	1			1			1	1		NI?TE	Nitella
Backwater	8/25/04	41.31523	-85.66734	338	6.0	1			1			1	1		NOAQVG	No aquatic vegetation
Backwater	8/25/04	41.31555	-85.66614	339	5.0	1			1			1	1		NULU	Yellow pond lily
Backwater	8/25/04	41.31606	-85.66475	340	4.0	1			1			1	1		NYTU	White water lily
Backwater	8/25/04	41.31648	-85.66374	341	3.0	5			5			1	1		POAM	Large-leaf pondweed
Backwater	8/25/04	41.31542	-85.66486	342	4.0	0						0	0		POCR3	Curly-leaf pondweed
Backwater	8/25/04	41.31474	-85.66553	343	5.0	1					1	0	0		POFO3	Leafy pondweed
Backwater	8/25/04	41.31411	-85.66659	344	5.0	2			2			1	1		POGR8	Variable pondweed
Backwater	8/25/04	41.31392	-85.66771	345	4.0	0						0	0		POIL	Illinois pondweed
Backwater	8/25/04	41.31357	-85.66676	346	3.0	0						0	0		PONO2	American pondweed
Backwater	8/25/04	41.31415	-85.66575	347	5.0	0						0	0		POPE6	Sago pondweed
Backwater	8/25/04	41.3148	-85.66455	348	3.0	1	1		1			2	1		POPR5	White-stemmed pondweed
Backwater	8/25/04	41.31549	-85.66365	349	3.0	5			5			1	1		POPU7	Small pondweed
Backwater	8/25/04	41.31547	-85.66263	350	2.0	3	1		3			2	1		PORI2	Richardson's pondweed
Backwater	8/25/04	41.31475	-85.66301	351	4.0	4	3		1			2	1		POZO	Flat-stemmed pondweed
Backwater	8/25/04	41.31417	-85.66383	352	3.0	3			3			1	1		UTMA	Common bladderwort
Backwater	8/25/04	41.31364	-85.66438	353	4.0	1			1			1	1		VAAM3	Wild celery, eel grass
Backwater	8/25/04	41.31336	-85.66531	354	3.0	3			3			1	1		WO?LF	Watermeal
Backwater	8/25/04	41.31362	-85.66338	355	4.0	2		1	2			2	1		ZAPA	Horned pondweed
Backwater	8/25/04	41.31382	-85.66225	356	3.0	5	4		2			2	1		ZODU	Water stargrass
Backwater	8/25/04	41.3144	-85.66126	357	3.0	5	2		4			2	1			
Backwater	8/25/04	41.31374	-85.66066	358	2.0	5	1		5			2	1		Count	34
Backwater	8/25/04	41.31301	-85.66107	359	3.0	4	2		2			2	1			
Backwater	8/25/04	41.31216	-85.66097	360	4.0	5					5	0	0			
Backwater	8/25/04	41.31128	-85.6607	361	4.0	5			1		5	1	1			
Backwater	8/25/04	41.31019	-85.6606	362	4.0	5			1		5	1	1			
Backwater	8/25/04	41.30891	-85.66002	363	5.0	5					5	0	0			
Backwater	8/25/04	41.30761	-85.65996	364	4.0	5			2		5	1	1			